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The Practical Teacher

Price Sixpence.

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W. P. WORKMAN, M.A., B.Sc.,

Head Master, Kingswood School, Bath; late Fellow of Trinity College, Cambridge.

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'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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WELL-KNOWN TEACHERS AT WORK.

XLII.—MR. THOMAS WALLACE, F.E.I.S.,

Rector, High Public School, Inverness, N.B.

PROFESSOR BLACKIE, one of nature's own children, has sounded the praises of the 'Capital of the Highlands' in the following sonnet:—

'Some sing of Rome, and some of Florence; I
Will sound thy Highland praise, fair Inverness;
And, till some worthier bard thy thanks may buy,
Hope for the greater, but not spurn the less.
All things that make a city fair are thine,
The rightful queen and sovereign of this land
Of bens and glens, and valiant men who shine
Brightest in Britain's glory roll, and stand
Best bulwark of her bounds—wide circling sweep
Of rich green slope and brown empurpled brae,
And flowery mead, and fair in-winding bay.
Temple and tower are thine, and castled keep,
And ample stream that round fair gardened isles
Rolls its majestic current, wreathed in smiles.'

In 'wild environment' and 'combination of sea and land beauty,' we quite endorse the statement that 'Inverness is as near Paradise as earth can be.' Amid the variety and excellence of its educational temples the High School stands prominent as an architectural gem. The foundation stone was laid in 1879. It is an imposing two-storied edifice, with a tower from which we get a magnificent view of the splendours of Inverness—the mountain forms girt with blue sashes of clouds, morning glories, and evening glows. The school—a view of which is subjoined—has a beauty all its own. You feel what Ruskin calls the 'deep sense of voicefulness' in the structure and its surroundings. The shrubbery and grassy plots in front, the playground of three acres behind, the wealth of appliances for mental and physical culture, the bright class-rooms, and the spacious gymnasium, all voice the truth that the glory of a school building and of its accessories lies in its complete adaptation to purpose. Architect and School Board have evidently been imbued with the responsibility and requirements involved in planning a temple of learning.

Historical Notes.

This modern structure has taken the place of the well-known Free Church Institution of Disruption times. Carried on on the departmental system, and managed by the Free Church of the Burgh, the old school furnished a high-class secondary education, and proved a feeder on a somewhat extensive scale to the Scotch Universities. The foundation stone of this famed institution was laid in 1847 (July 6th). Dr. Morrison, the present Rector of the Free Church Training College, Glasgow, was at one time Rector of this school. On entering the new school, the departmental system was discontinued, and the graded system adopted. Up till Christmas, 1894, the pupils in Ex-VI. Standard, numbering considerably over 100, received instruction in Latin, Greek, Mathematics, French, German, Science (South Kensington), University Local Examinations, L.L.A. degree, Trinity College, London (Music). The School Board provided a liberal and highly qualified staff to assist the Rector in carrying on the work, which is characterised as 'solid academical training of the highest order.' In December, 1894, a Secondary Department of the High School was started in a separate building, to which all the Ex-VI. pupils in all the Board Schools are to be annually drafted. This department is well equipped with a highly efficient staff, and bids fair to sustain the historic fame of the High School for Secondary Education. Rocked hither and thither by the adjustment and readjustment of educational machinery in the Burgh during the past, the school has never stood still. It has been, and still is, the palpitating heart and centre of the 'forward movement.'

The Rector, Mr. Wallace, aims at being in the van in education. All around the word is 'Forward,' and here it is being obeyed to the letter. As a true born educational pilot, Mr. Wallace recognises the modern currents, gauges their force and direction, keeps his vessel's head to the 'vantage point,' and steers right on. Some of the drastic changes through which he has been called to pass might shake the nerve and damp the enthusiasm of some of us. Mr. Wallace, as 'a strong central trunk,' from

SAMPLE OF RECORD OF RESULTS.—INVERNESS HIGH SCHOOL.

Pupil's Name.	Dictation.	Simple Addition.	Simple Subtraction.	Simple Multiplication.	Simple Division.	Compound Addition.	Compound Subtraction.	Compound Multiplication.	Compound Division.	Notation.	Writing.	Reading.	Meanings.	Poetry.	Grammar.	Analysis.	Composition.	History.	Geography.	MAY 18/5. REMARKS.
John Wilson	X	X	X	X	0	X	0	X	X	X	X	X	X	X	X	X	X	X	X	
*James Smart	0	X	X	X	X	0	X	X	0	X	0	X	X	0	X	X	X	0	X	* The boy James Smart requires special attention.
William Young ...	X	X	X	X	X	X	X	X	X	0	X	X	X	X	X	0	X	X	0	
David Fraser	0	X	X	0	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	

SAMPLE OF SCHEME OF WORK.—STANDARD III.

	READING.		WRITING.			ARITHMETIC.							ENGLISH.				GEOGRAPHY.		HISTORY.
	Reading.	Meanings.	Dictation.	Compositn.	Copy Book.	Figures.	Notation.	Table.	Addition.	Subtraction.	Multiplicn.	Division.	Repetition.	Meanings.	Parsing.	Analysis.	Political.	Physical.	
JANUARY	A. 1—30 B. 1—25 C.	Same as reading	5 lines from A	A short letter every Monday Morning.	Great care to be taken with Penmanship		7 figures	Up to 9 times	10 figures, and compound addition	10 figures, and compound subtraction	Sums of 6 figures by 4 figures	Sums of 6 figures by 2 and 3 figures	10 lines	Same	Nouns, adjectives	Simple sentences	Map of the World, mountains	7 terms, size and shape of the earth.	pp. 67—81
FEB.	A. 30—58 B. 25—50 C.	,,	,,				,,	The whole	,,	,,	Compound multiplication by 1 fig.	,,	20 lines	,,	Nouns, adjectives, pronouns	,,	European countries and capitals	10 terms, springs, rivers	81—97
MARCH	A. 58—88 B. 50—75 C.	,,	,,				,,	Money table	,,	,,	C. M. by 2 figures	,,	30 lines	,,	Same with verb	,,	Asia, countries and capitals	13 terms, snow and ice	97—113
APRIL	A. 88—114 B. 75—100 C	,,	,,				8 figures	Money and time tables	,,	,,	,,	Compound division by 1 figure	40 lines	,,	Same with adverb	Adverb clause	Same, N. America	16 terms, formation of islands, capes, bays	113—127
MAY	A. 114—144 B. 100—125 C.	,,	,,				,,	,,	,,	,,	,,	Simple division by factors and C. div.	50 lines	,,	Parts of speech	Adjective clause	Same, S. America	All the terms, hail, rain, dew	127—144
JUNE	A. 144—175 B. 125—150 C.	,,	,,				9 figures	,,	,,	,,	,,	,,	60 lines	,,	,,	Noun clause	Australia	All the terms, sun and moon	144—153
AUG.	Same as January and February.																Scotland.		
SEPT.	Same as March and April.																Scotland.		
OCT.	Same as May and June.																Scotland.		

The Inspection takes place in November.

which branch schools can be multiplied for higher or technical education, settles down to his prescribed work in the true spirit of the enthusiast who says, 'Given a field, it is required to tap all its resources.' He certainly finds the resources richer and deeper than he ever contemplated. 'Desire to learn' is the foundation on which his signal success as a teacher rests. While accomplished results of the most brilliant kind were set before us, much that we saw was distinctly prophetic and anticipatory. During our brief visit he gave us a panoramic view of his field of labour. Outsiders conversant with his work furnished us with further insight into the past achievements and the successes of the hour. From what we saw and heard, we have no hesitation in saying that in limitless inventiveness, inexhaustible power of resource, proved experience, fertility of brain, and warmth of educational fervour, Mr. Wallace stands second to no teacher in the country. The Inverness School Board has escaped the 'reform mania' of the feather-brained—a reform which unsettles everything and establishes nothing. The members have taken a broad, calm, and intelligent view of the educational problem in all its phases. With clear insight into the wants of the community, they have inaugurated a scheme of elementary and secondary education which is at once liberal and highly practical. Moving along the stream line of the modern progressives, they recognise the immense value of sound foundation work. Hence the reason that we have in the Inverness High School one of the finest equipped institutions for Kindergarten and elementary instruction in the kingdom. Here you shrink from the name 'Elementary' in its bald sense. Everything is touched into High Class, and converges by outreaching efforts into the solid substantialities of appreciated higher subjects. The local Board has to be congratulated on its fortunate acquisition in the Rector of the High School. Taste-creation and foundation-laying struck us as fields where he stands without a rival.

Yours faithfully
Thomas Wallace

Building and Equipment.

In American phrase, the 'campus' of the school is ideal. From a sanitary standpoint of view the site is perfect. The recitation rooms are longer, loftier in ceiling, and more perfect in lighting, heating, and ventilation than most of our southern class-rooms. There is a liberal supply of all modern appliances. On the ground floor we have a splendid hall for collective teaching and drill, measuring 45 ft. by 52 ft.; three infant class-rooms; lavatories, and retiring rooms for male and female teachers. By two flights of stairs—an important factor for the comfort of the pupils—we get to the second floor. Here we have large airy rooms for Standards I. to VI. The subjoined plans will help our readers to see the arrangements. The broad corridors afford ample space for large numbers to move in and out rapidly.

Electric Bells.

All the class-rooms are connected with the Rector's private room by means of electric bells. There is a duplicate set of 'buttons' in one of the class-rooms. The teacher in that room has charge of and controls the dismissal of all the classes. He touches the buttons at a certain hour; all the work over the whole building is instantly stopped, the doors open, and the classes are dismissed to the music of an organ placed in the upper corridor. The girls march two and two down one flight of stairs and the boys in similar order down another. The pupils all assemble to music, and in this way over 700 pupils are in their seats in less than five minutes after the big bell in the tower stops. We witnessed the dismissal. The promptness, quiet, uniform movement, and disciplinary control were matchless. The pupils in the class-rooms, drill and marching, evidently take a pride in carrying themselves well. The graceful actions of many of their number proved that harmony of body and will settled down into a habit.

Physical Culture, Music, and Singing

are special features of this school. We have two organs and three pianos in daily use. Muscle, finger, and lung exercises are most efficiently utilised in cultivating the physical being, and in promoting mental taste and development. Teachers and pupils alike enter into the spirit of the work in these branches. Mr. Wallace has an enthusiastic drill instructor for his girls and Kindergarten pupils in Miss McLennan. Her training is based on the clear understanding of laws and principles. Her department will be described in an early number of the 'Infant Mistress.' The staff, as a whole, try to cultivate the musical ear, and to put the pupils in sympathy with the rhythm and poetry of motion.

Maypole dances, and attractive exercises with wands, dumb-bells, rings, and Indian clubs, etc., prove most beneficial in 'relieving mental strain,' and in producing 'bodily grace and beauty.' The precision of the drills exhibited in the Infant and Senior Departments was faultless.

The institution possesses a complete set of

Meteorological Instruments,

presented by Mrs. Forbes, of Culloden, in memory of her late husband. The school is practically a Meteorological Station. The observations are made twice a day, and are forwarded to the Scottish Meteorological Society at the close of every month. These observations are also to be published in the Report of the Medical Officer of Health for the County. To the senior pupils, and to the staff generally, this subject is a great source of healthy entertainment and valuable instruction. In the hands of Mr. Wallace, these instruments and his extensive collections of minerals, fossils, plants, and antiquities of the locality prove heart-inspiring and brain-furnishing knowledge. He is a scientific celebrity, and is reckoned an authority on Geology and Archæology. He is a member of the Edinburgh Geological Society, and of the Scottish Society of Antiquarians. Unlike too many members of these societies, who are mere honorary sleeping members, Mr. Wallace is a working and stimulating member. He creates a scientific atmosphere around him. His collections are available to the whole staff for educational purposes. Walking excursions, led by himself and members of his staff, are frequently organised during the session. The pupils collect plants, rock specimens, etc., during these excursions, and are at the same time formally instructed in the Geology, Natural History, and antiquities of the locality.

Fountains of inspiration are in this way opened up for the pupils in and out of school. 'An unusual eagerness for knowledge,' we were informed, characterised the High School boys and girls. Doubtless this is due to the sympathetic way in which Mr. Wallace admits his pupils to the stirring sensations that are felt in the great workshop of nature. Scholars are not fed here on the dainties of books. Scope and inducement are put within the reach of all to drink at the fountain heads of scientific truth.

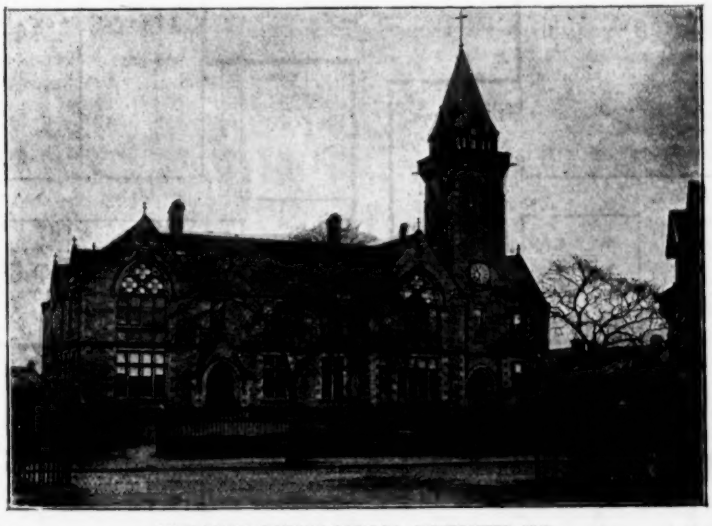
Prizes are offered for the best collections of plants. Old pupils who have been interested in these studies, specially those who go abroad, send to the Rector natural history specimens of every kind. The last contributions were pre-historic vases from Peru and arrow heads from Japan. Mr. Wallace affirms that 'any teacher who is himself an interested and intelligent collector, and who will show his specimens to his pupils and entertain them with a scientific talk, will soon gather round him a band of collectors who will enrich his stores of specimens to any extent.' He also advocates public exhibitions of the collections for stimulating purposes. The window sills are filled with glass cases containing numerous objects of interest, while the walls of all the rooms are adorned with pictures of all sorts, chiefly of an educational value. He is at present engaged in working an idea of class room decoration by pictures and photos, etc., that will illustrate the work of the class which regularly meets in that room. This will completely transform these handsome class rooms into veritable morning lands of culture. The mind of Mr. Wallace teems with scientific facts and educational wrinkles. Everything in the educational firmament is familiar to him. The discoveries of the past and the present, and those looming in the future, are all handled intelligently, and a vast amount of nutriment for nineteenth century pupils is extracted from them. He deals with science as he deals with the beauties of nature around him. Freedom of access is a privilege never to be dispensed with. He tolerates no stained windows in the class rooms. He has no faith in 'caging up pupils,' and 'shutting them up in a jail,' mentally or physically. 'Something fresh to look at is a stimulant to teacher and scholar.' Light and brightness, grassy sward, and blushing flowers 'never hamper work or discipline.' Often have we felt this, and we would commend this wrinkle to our readers, specially to those who have a scrap of Nature's beauty within reach. Let Nature, the 'dear old nurse,' have free scope to look on her children, and let them have a peep occasionally at her smiling face. Such a peep may banish a cloud and open a pathway for the beams of knowledge.

His Schemes of Work—Tests and Records.

These are models of school craft. The variety of activities kept in motion by Mr. Wallace is bewildering.

We select his scheme of work for Standard III., and put it before our brethren along with the time-table and the record of results, as taken out of the Rector's monthly report on the same standard after examination.

The inspection takes place in November. All the work is tested by the Rector at the end of *each month*, and the results tabulated in a book form as shown in tabulated list subjoined (for four pupils). The book of results is left with the teacher. By this method every teacher in the school has a continuous record of his work, and the head master has the satisfaction of knowing that the work has been gone carefully over twice before the Inspection. When prizes are given at the end of the school year, so many marks can be given for each pass in the above examinations. Mr. Wallace gives 5 marks for each pass. This is one of the most thorough-going methods we have met with. It keeps the teacher in close touch with the Rector, and it brings prominently into view the pupils that require special attention. The devices for pulling them up were then gone into, but we cannot reproduce. Suffice it to say that they were all 'humane devices.' The existence of a code is not felt here. The work of child culture stands out supreme. Subjects are put before the pupils and spread open in the most enticing form. No cram, and no gulping down of crude indigestible facts or principles. The bright pupils are not dragged down daily into the darkness of their weaker companions and made to stand and look on. Sections or divisions exist in these classes, and promotion from one to the other stirs up wholesome rivalry, and brings up all and sundry to an exceptionally high level.



THE HIGH PUBLIC SCHOOL, INVERNESS, N.B.

Attendance.

Like most teachers Mr. Wallace is very much troubled with 'irregulars.' Many plans have been tried by him. He found there 'was no stimulus for the lazy and indifferent.' He has 'strong objection to punish for this offence.' He views this as a 'wild wrong way of righting a wrong.' 'The parents are to blame, and they alone are the parties to be dealt with.' 'Many parents have such crude notions about school and children, that their children can only be saved by being taken from them.' As to dunces, Mr. Wallace is at one with Mr. Adams, the Rector of the F. C. Normal College, Aberdeen, who considers that 'in schools of one thousand pupils, 5 per cent. may be dunces.' As we should expect, Mr. Wallace shrinks from calling any pupil a dunce. He enumerated several instances of pupils who were considered dunces by one teacher, but who became good average pupils under another.

Bible Knowledge

occupies a place in the school. The work is carried on under the 'McDougall Trust'—a fund left by an Inverness gentleman. If Mr. Wallace could be set free to work out his own broad and wide scheme, we feel sure it would bring about more soul summer than the disjointed dipping into particular books of Scripture, characteristic of this and other schemes which have been submitted to us. Mr. Wallace was at one with us that 'there should be clear teaching of the grounds of moral obligation' in the school, seeing that 'such teaching is on the decline in the homes.' His attitude to parents is rational: 'The only relation I desire is that they send their children to school regularly, and leave the rest to me.' He is always prepared 'to listen to anything reasonable.' He points out very firmly that in a 'school the individuality must be at times sunk for the community.'

Home Work

he reduces to a minimum, and thinks that 'six hours a day at lessons is quite enough for the body and mind of a growing child.'

Pupil Teachers.

In training pupil teachers in the practice of teaching, he 'finds it much better for them to have a small class in a room by themselves, which they are to consider their own, and for which they are responsible.' In a room along with another teacher 'they get usually drudgery work to do.' In the High School, Standards I., II., and III. have always been taught by pupil teachers on the above method (separate room and small class). Mr. Wallace superintends these. The pass has been 'nearly cent. per cent.' in the old days of individual examination, and he has got Excellent since.

Outstanding Features

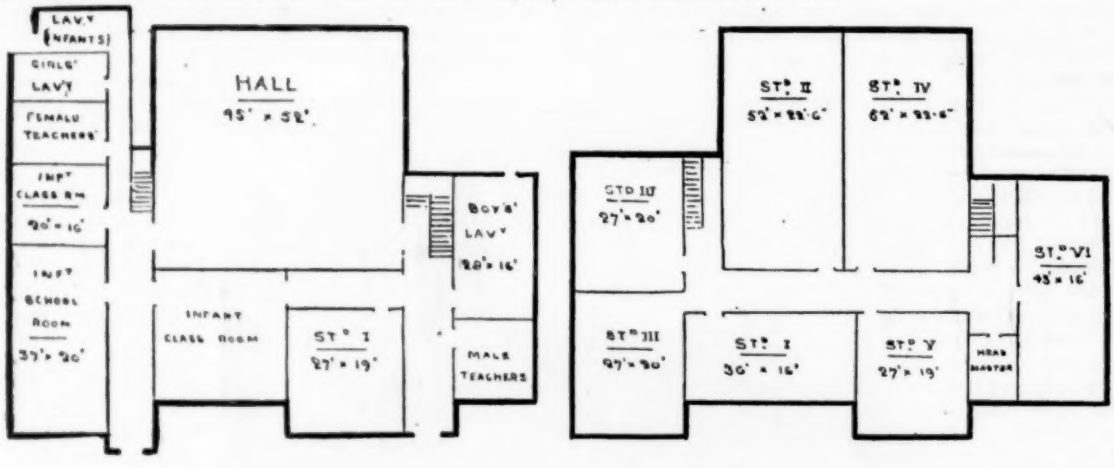
are innumerable. We must sum up by noting two. The collective solidarity of all the departments is very marked. The High School, as conducted by Mr. Wallace, is a model of well focussed methods and influences for developing that type of intellect which is capable of profiting by Higher and University Education.

The devices for aiding, encouraging, and inciting teachers and pupils radiate from a centre vitalised with true educational energy, and with that subtle spiritual influence which is the foster mother of life

and the executioner of death. Mr. Wallace creates such an amount of sunshine, warmth, light, and beauty in his school that the budding intelligences around him seem to burst forth into leaf, flower, and fruit as naturally as do the floral beauties that deck the grassy belts that girdle his school. He is not only the head of the school, but the living bond of union that unites all into a potent educational factor.

With hopeful optimism he views the deepening interest in education as containing the germs of all desirable improvements for the profession. The turbulent grumblings about teachers' rights that agitate so many minds find no response in a mind filled with the teacher's duties, responsibilities, and opportunities of moulding the young spirits that are shortly to occupy the high places of the earth. The Educational Institute of Scotland has no more loyal Fellow on her roll. As a citizen we heard much of his public spirit, while the church owes him a debt of gratitude for valued services amongst the young. If we were to put our conception of Mr. Wallace and his work into one word, it would be Enlightenment. His school, as we found it, can only be described as a 'High class up-to-date educational nursery glittering with groups of the children of the light.'

He is a Fellow of the Geological Society of Edinburgh; Fellow of the Royal Society of Antiquaries, Scotland; Fellow of the Educational Institute of Scotland, for some time one of the Vice-Presidents and a member of the Board of Examiners; Secretary to the Northern Association of Scientific Societies; one of the original founders of the Inverness Scientific Society and Field Club; author of several papers to be found in the transactions of various scientific societies.



ELEMENTARY LESSONS IN AGRICULTURAL ZOOLOGY.

BY PROFESSOR J. R. GREEN, SC.D.,
Late Examiner in Botany to the University of Cambridge, and
F. L. GREEN,
Late Science Mistress in the Clifton High School.

CHAPTER V.—ARTHROPODA—JOINTED-LIMBED ANIMALS.

THIS class includes a large number of families and comprises many of very varied forms, the spiders, centipedes, insects, and crustaceans being the representatives of its leading sub-divisions. The bodies of these animals consist of a number of joints, which is, however, not constant, but varies in the different members of the sub-kingdom. These joints, or segments, lie in a line from one end to the other; at first alike, they become differentiated to a certain extent as the animal grows to maturity. The segments are variously united, sometimes some of them being fused together, causing the body apparently to consist of a smaller number of parts than there really are present. Thus in the insects we have three regions—head, thorax, and abdomen—each composed of several segments; in the spiders and mites (Arachnoidea) we have either two chief regions, cephalothorax and abdomen, or the whole of the segments may be united into a single piece, almost destroying the idea of a segmented animal at all. In addition to the segmentation, these creatures are furnished when adult with jointed limbs, a feature which marks them off from the next sub-kingdom, the worms, which are also made up of a number of similar segments, but which have either no limbs at all or simple ones, which are never jointed. The Arthropoda have other distinguishing features besides this mode of formation of the body; the head is always furnished with several successive pairs of jaws, which are endowed with a lateral movement; the skin is soft when growing, but as the animal grows older it is found to be composed of hard protective pieces. There is no internal skeleton, the muscles being attached to the skin; the nervous system lies for the most part along the ventral side of the body, and consists of a pair of ganglia in each segment united to each other and those of the segments in front of and behind them by nerve fibres. The most anterior ganglion, or cerebral one, situated in the head, is connected with the next one by a cord passing on each side of the gullet and forming a kind of ring of nervous matter. The several nerves that supply the muscles, viscera, etc., come off from the ganglia in the several segments. The ventral position of the nervous system is in marked distinction from that of the vertebrata, where it is always dorsal.

There is a good deal of difference in the group as to the kind of respiratory organs its members possess, which is of course what one would expect when the different habits of life are taken into account. The crustaceans, being aquatic, are furnished with gills; insects and centipedes have curious air tubes in various positions in their bodies; spider-like animals sometimes breathe by similar structures and sometimes by the skin. Some of the Arthropoda bear winged appendages, such as many insects; others have nothing of the kind. The wings differ essentially from those of birds, not being transformed limbs as in the latter case.

The Arthropoda are divided into four classes:—I. Insecta (insects); II. Myriapoda (centipedes); III. Arachnoidea (spiders, mites, and scorpions); IV. Crustacea (crayfish, crabs, woodlice, etc.).

CLASS I.—INSECTA.

This class is perhaps the most difficult to deal with satisfactorily in an elementary series on Agricultural Zoology. The number of its members with which the farmer comes into close relations is so great, and the work they do, both in hindering and helping his operations, is so varied, that it is hard either to describe them in detail or to select leading types to illustrate the group. Perhaps no

INVERNESS HIGH SCHOOL.—TIME TABLE.

STANDARD I.

—	Monday.	Tues.	Wednes.	Thurs.	Friday.
9.0—9.25.	Religious Instruction.				
9.25—9.50.	Girls—Sewing. Boys—General.				
9.50—10.0	Interval and Registers.				
10.0—10.30.	Drill	Singing	Writing	Singing	Writing
10.30—11.0.	Tables or Men Arith.	Poetry	Tables & Men-Arith.	Poetry	Tables & Men Arith.
11.0—12.0.	Arithmetic	Drawing	Arithmetic	Arithmetic	Drawing
12.0—1.5.	Interval and Registers.				
1.5—1.30.	Writing	Writing	Dictation	Dictation	Dictation
1.30—2.0.	History	Geography	History	Geography	History
2.0—3.0.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.

STANDARD II.

—	Monday.	Tues.	Wednes.	Thurs.	Friday.
9.0—9.25.	Religious Instruction.				
9.25—9.50.	Girls—Sewing. Boys—General.				
9.50—10.0.	Interval and Registers.				
10.0—10.30.	Dictation	Writing	Dictation	Singing	Dictation
10.30—11.0.	Drill	Arithmetic	Writing	Writing	Arithmetic
11.0—12.0.	Arithmetic	Drawing	Arithmetic	Arithmetic	Drawing
12.0—1.0	Interval and Registers.				
1.0—2.0.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.
2.0—2.30.	Singing	Grammar	Writing	Grammar	Poetry
2.30—3.0.	History	Geography	History	Geography	History
3.0—3.5.	Interval.				
3.5—3.30.	Grammar	Tables	Poetry	Grammar	Grammar
3.30—4.0.	Reading	Arithmetic	Geography	History	Reading

STANDARD III.

—	Monday.	Tues.	Wednes.	Thurs.	Friday.
9.0—9.25.	Religious Instruction.				
9.25—9.50.	Girls—Sewing. Boys—General.				
9.50—10.0.	Interval and Registers.				
10.0—10.30	Dictation	Dictation	Dictation	Dictation	Arithmetic
10.30—11.0.	Writing	Arithmetic	Writing	Writing	Arithmetic
11.0—12.0.	Arithmetic	Drawing	Arithmetic	Arithmetic	Drawing
12.0—1.0.	Interval and Registers.				
1.0—2.0.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.
2.0—2.30.	Drill	Poetry	Singing	Grammar	Poetry
2.30—3.0.	History	Geography	History	Geography	History
3.0—3.5.	Interval.				
3.5—3.30.	Grammar	Tables	Poetry	Tables	Grammar
3.30—4.0.	Reading	Men-Arith.	Geography	History	Reading

STANDARD IV.

—	Monday.	Tues.	Wednes.	Thurs.	Friday.
9.0—9.25.	Religious Instruction.				
9.25—9.50.	Writing	Grammar	Writing	Writing	Writing
9.50—10.0.	Interval and Registers.				
10.0—11.0.	Arithmetic	Arithmetic	Arithmetic	Arithmetic	Arithmetic
11.0—11.30.	Drawing	Dictation	Drawing	Dictation	Dictation
11.30—12.0.	Drawing	Men-Arith.	Drawing	Tables, etc.	Men Arith.
12.0—1.0.	Interval and Registers.				
1.0—1.45.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.
1.45—2.0.	Spelling	Spelling	Spelling	Spelling	Spelling
2.0—2.30.	Geography	History	Singing	History	Geography
2.30—3.0.	Drill	Geography	Grammar	Poetry	Grammar
3.0—3.5.	Interval.				
3.5—4.0.	Reading	Boys—Latin.	Girls—Sewing.		

STANDARD V.

—	Monday.	Tues.	Wednes.	Thurs.	Friday.
9.0—9.25.	Religious Instruction.				
9.25—9.50.	Writing or Dictation	Mathemat.	Writing or Dictation	Singing	Mathemat.
10.0—10.5.	Interval and Registers.				
10.5—11.0.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.	Reading, etc.
11.0—12.0.	Drawing	Comp. and French	Drawing	Comp. and Map Draw.	Comp. and French
12.0—1.0.	Interval and Registers.				
1.0—2.0.	Arithmetic	Arithmetic	Arithmetic	Arithmetic	Arithmetic
2.0—2.30.	Geog.& His. (alternately)	Geog.& His. (alternately)	French	Geog.& His. (alternately)	Drill
2.30—3.0.	English	English	Singing	English	Geog. or History
3.0—3.5.	Interval.				
3.5—4.0.	G. Sewing B. Latin	G. Sewing B. Latin	G. Sewing B. Latin	French and Mathemat.	French and Mathemat.

STANDARD VI.

—	Monday.	Tues.	Wednes.	Thurs.	Friday.
9.0—9.25.	Religious Instruction.				
9.25—9.50.	Mathemat.	Composition	Mathemat.	Singing	Composition
9.50—10.0.	Interval and Registers.				
10.0—11.0.	Arithmetic	10.0—10.30. Writing	Arithmetic	10.0—10.30. Writing	10.0—10.30. Writing
11.0—12.0.	Drawing	10.30—12.0. Arithmetic	Drawing	10.30—12.0. Arithmetic	10.30—12.0. Arithmetic
12.0—1.0.	Interval and Registers.				
1.0—2.0.	English	English	English	English	English
2.0—2.30.	Geog. or History	Geog. or History	Geog. or History	Geog. or History	Geog. or History
2.30—3.0.	French	Mathemat.	Singing	French	Mathemat.
3.0—3.5.	Interval.				
3.5—4.0.	G. Sewing B. Latin	G. Sewing B. Latin	G. Sewing B. Latin	French and Mathemat.	G. Sewing B. Latin

other class of animal can be said to be equally destructive, for, though the power of a single individual in that direction is but slight, the numbers of individuals amount to millions. Each again has almost a distinct life history, which is frequently or even generally associated with its power of doing evil to growing plant, or quiescent tuber or root. In no other class do we find, perhaps, such an enormous power of reproduction, a power which if unchecked would lead to devastation of all vegetation. On the other hand, again, hardly any class is more beneficial to the farmer, the check mentioned being largely that caused by the warfare which the various insects are waging among themselves, so that many of the group restrain the damage which would accrue from the activity of the others, and so confine it within limits.

The peculiarities of the true insects as a class are distinctive; very often any small creeping animal, provided or not with wings, is popularly spoken of under this name; spiders and centipedes, mites and woodlice, are all confused together with beetles, butterflies, and moths. This must be avoided; they are all arthropods, but certainly not all insects.

The true adult insect is marked by the following points:—1. The breathing apparatus takes the form of air tubes, or *tracheae*, which are much branched tubes winding about in the interior of the body and ultimately investing the various organs in a fine network, so that each part is supplied with oxygen. They usually open by a number of orifices, called *stigmata*, placed on each side of the body. 2. The segments of its body are fused together into three regions, which are known respectively as the *head*, the *thorax*, and the *abdomen*. On the head there are placed certain appendages known as the antennae, or feelers, and also the jaws; the head bears two eyes. The thorax is composed of three segments, the front one of which bears a pair of legs, and each of the others a pair of legs, and in most cases a pair of wings also. When these are present they are derived from the skin of the thorax, and do not represent appendages. The abdomen consists of a variable number of segments, none of which possesses limbs.

The eyes of insects are of the type known as *compound*, each being made up of a large number of smaller eyes. A few simple eyes may be present in addition to these larger ones. The antennae are not fully understood; they serve in many cases as organs of touch, but they seem to have besides some other function about which we know little or nothing; in many cases they seem in some way to be means of communication between individuals. There is a good deal of variety in the structure of the mouth, but all are based upon one type, the varieties consisting in modifications of the fundamental parts according to the habit of life of the particular insect. In the typical mouth we find three pairs of jaws, the first and largest of which are called the *mandibles*, and are sometimes formidable nipping claws. The second pair are smaller and more delicate, and are called the *maxillae*. These two pairs are mobile from side to side; the third pair are immovable and fused together. They form the lower lip or *labium*. The jaws are arched over by a projection of the skin of the head, which forms the upper lip or *labrum*.

The limbs of the adult insect consist of 5 segments—the hip or *coxa*, the *trochanter*, the thigh or *femur*, the shank or *tibia*, and the foot or *tarsus*, the latter being three to five-jointed. The wings vary in the several groups, being sometimes delicate and transparent, as in the flies; scaly, as in the moths and butterflies; or horny and chitinous, as in the forewings of beetles. In the latter case these forewings serve as sheaths for the other pair, which are the true organs of flight.

In the adult insect the abdomen bears no appendages; but in the young state of certain insects, such as the caterpillars of moths and butterflies, it is furnished with curious suckerlike appendages known as the pro-legs, which aid in locomotion.

The abdomen in most insects bears at its extremity certain appendages which are used in the deposition of the eggs, and are known as ovipositors.

Most insects reproduce themselves by laying eggs, and most that are hatched from eggs undergo curious changes of bodily form and habit of life before reaching the adult condition. These changes are often spoken of as the *metamorphosis* of the insect.

In the cases of those insects in which this metamorphosis is most complete, there are three definite stages which form the life cycle. The egg when hatched gives origin to the first stage, or *larva*; this may be a caterpillar, grub, or maggot. The first of these has a definite well-defined head with characteristic jaws, three pairs of thoracic legs, which are jointed like those of the adult, and a varying number of unjointed pro-legs. Grubs have a head much like that of the caterpillar; but with the exception of the grub of the wire-worm, they have no abdominal pro-legs. Some of them have thoracic legs, such as the larvæ of the cockchafer and the leaf-beetles; others have none, such as those of fleas and weevils. Maggots have no legs, and the head is not clearly marked off from the rest of the body, being only recognisable by the presence of the mouth and mouth parts.

During the larval stage the insect feeds vigorously and grows, laying up for itself in its substance excess of material generally in the form of fatty bodies. After a time it passes into the next stage, that of the pupa, sometimes spinning a cocoon in which to hide itself during this period of its existence, in which it is resting, unmoved and defenceless.

The pupa has the general shape of the adult insect; the outer case or skin sometimes surrounds very closely every part of the body; sometimes it forms a covering which only faintly exhibits the outlines of the various parts. During its pupa stage the insect takes no food; it remains placid and immobile, unless disturbed; it lives at the expense of the reserve materials it formed and stored during its larval stage. The pupa condition lasts a variable time, varying from one to six months. At the end of that time the casing bursts, and the perfect insect or *imago* emerges from it and takes to flight.

It is not every insect that goes through this series of changes. The pupa stage is sometimes omitted, when the metamorphosis is said to be incomplete. Its form then generally changes gradually from that of the larva to that of the imago, the alterations taking place at definite times when from growth, having temporarily reached its limit, it is compelled to cast its skin, or *moult*. Each successive moult brings the form nearer and nearer to that of the perfect insect. The necessity of moulting is not confined to the larvæ of insects that undergo only incomplete metamorphosis. The skin of the arthropod is hard and inextensible, and when the insect in its growth has stretched it as far as it can be made to stretch, either growth must cease or the covering give way. Caterpillar skins can often be found thrown off under these conditions. When the old coating has been displaced, the new skin underneath is found to be much like the original one, but soft and capable of stretching. As growth goes on it becomes gradually harder, until it has to give way to another new one.

The wings are developed in the case of insects showing incomplete metamorphosis at the last moult but one, but they are very rudimentary and imperfect. Fully developed wings are only present after the last moult.

The insecta are divided into eleven families, or natural orders, which are characterised as under:—

1. *Coleoptera* or *Beetles.*—These have biting mouth parts, and very mobile thorax. The four wings are in the form of hard covers, which protect nearly the whole of the body, leaving exposed only the head, part of the front of the thorax, and the top of the abdomen. These hard front wings, or *elytra*, entirely cover the hind wings, which alone are used for flight. They pass through the three stages of larva, pupa, and imago, the larvæ having only thoracic legs, and sometimes not at all; they possess a hard head with biting jaws.

2. *Orthoptera.*—These have biting jaws, but differ from the beetles in undergoing incomplete metamorphosis. The front wings are harder than the hind ones, which are membranous and folded. This order includes the earwigs, the cockroaches, the grasshoppers, the locusts, and the crickets.

3. *Neuroptera.*—The members of this order have biting mouth parts, and four membranous wings. The metamorphosis may be incomplete or complete. It includes the dragon-flies, may-flies, book-lice, ant-lions, etc.

4. *Hymenoptera.*—These have a short upper lip and mandibles, which are used for biting. The maxillæ, or second pair of jaws, are loose-jointed, and can be stretched out considerably, sometimes elongated, as in those which suck the honey from flowers. The wings are all membranous, but differ from the last in having few veins. The female usually has an ovipositor, which is sometimes modified into a sting. In this case the abdomen is furnished with poison glands. This family includes the wasps and bees, ants, ichneumon flies and gall-flies.

5. *Lepidoptera.*—These have sucking mouth parts, the two maxillæ being very long and spirally rolled up under the head, forming together a tube, which can be inserted into flowers to procure the honey. The larvæ have biting jaws. The body and wings are usually covered with hair-like structures or scales, which on the wings overlap each other. The metamorphosis is complete; the larvæ are caterpillars.

6. *Hemiptera.*—The mouth parts in this family are modified into a sucking and piercing beak; the head is small and the legs usually slender. Some have no wings, others have the forewings partly leathery and partly membranous; some have all four wings membranous. The metamorphosis is incomplete. The only members of this group which are of agricultural importance are the plant lice or *aphides*.

7. *Diptera.*—The mouth parts in these are elongated, adapted for sucking or piercing. The fore wings are generally well developed, but the hind ones are modified into club-like bodies. They have a complete metamorphosis; the larvae are always legless, most being maggots. The order includes the flies.

8. *Physopoda.*—These are very minute insects, possessing a peculiar jaw apparatus, with which they pierce the leaves and petals of flowers to obtain the juices of the plant. They have four small wings, and peculiar bladder like ends to their feet. The metamorphosis is incomplete.

9. *Aphaniptera.*—These have a laterally compressed body and a small head. The mouth parts are adapted for biting and sucking. The last pair of legs are long, giving the insect the power of springing or leaping. They have no wings. The metamorphosis is complete. The fleas are the chief members of the order.

10. *Parasita* or *Pediculina.*—This group includes the lice. They are marked by having a flattened body furnished with legs adapted for crawling among hair and feathers. The eyes are simple when present, but often the insects have none. They have no wings, and there is no true metamorphosis. The mouth parts are adapted for sucking or biting.

11. *Collembola*, including the spring-tails and tassel-tails.

To recapitulate, we have seen that :—

1. The class Arthropoda consists of animals with a segmented body and jointed limbs, a head furnished with several successive pairs of jaws, an exoskeleton, but no endoskeleton, and a ventrally placed nervous system.

2. The class includes the true Insects, the Centipedes, the Arachnoidea, or spiders, scorpions, and mites, and the Crustacea.

3. The Insecta have either two or three forms of body in their life cycle, and the changes they undergo in passing from one to the other constitute their metamorphosis, which may be complete, when they pass through the three forms, or incomplete, when they pass through only two.

4. The forms are known as the larva, the pupa, and the imago. In the first and third the insect is active, in the second quiescent. In the cases of incomplete metamorphosis, it is the pupa stage which is absent.

5. The insect's body when adult consists of three parts, each of a different number of the segments; these are the head, thorax, and abdomen. The head bears the eyes, antennae, and jaws; the thorax the six legs and four wings, and the abdomen has no appendages except the ovipositor.

6. The insects are divided into eleven groups or orders, which may be represented by the beetles, grasshoppers, dragon-flies, wasps, butterflies, plant-lice, flies, thrips, fleas, lice, and springs-tails.

TEACHERS' DRAWING LESSONS.

MODEL.

STANDARD VI.

BY E. BUFFERY RIDGE,

Art Master under the London School Board.

The long-necked Vase or Water-bottle.—Begin with a Freehand copy showing the vase in elevation, as described in the preceding lesson, Fig. 1 (half real size). Show the bottle, and point out that the artful nature of the curves makes the bulb look smaller than it really is, and that it measures in width *more* than half the total height.

Draw a centre line and divide it into four equal parts at *b*, *c*, and *d*. Draw cross-lines at these three points, and at the top and bottom. Divide *bc* into three equal parts. Now compare the widths at various points with the divisions of the centre line and with each other. The base is equal to *a*1, or one and a third times *ab*, while the top is somewhat greater than half the base. The top then bears the same relation to the base as does the greatest width to the height, *i.e.* a little more than one-half. Place a little more than *ab* on each side at *b*, and a little less than half the top on each side at *d*. Make *cg* equal the half-top. The foot *af* is one-third of *ab*, the rim taking one-third of *af*. Draw the remaining cross-lines—not measuring their lengths.

From one side of the top draw an equal curve to *g*, bending inwards slightly so as to give the required thinness of the neck at *d*, and continue this curve by a straight line running to the base. Repeat on the other side. A portion of these straight lines will

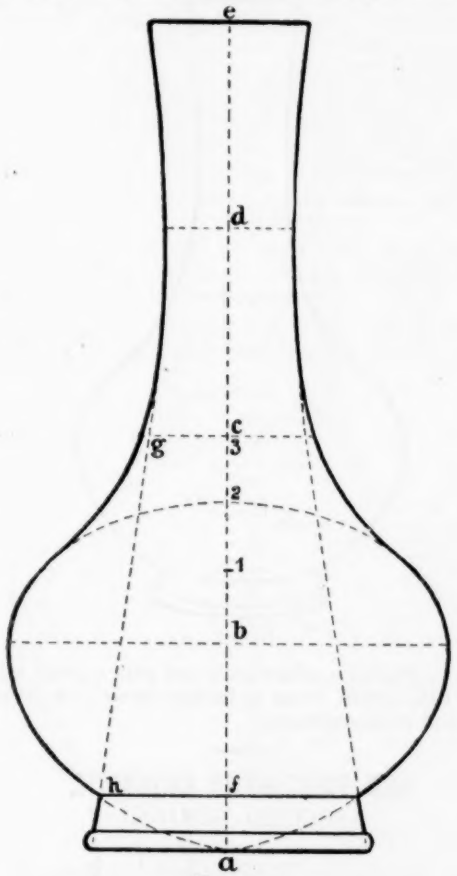


FIG. 1.

form the *sides* of the *foot* of the vase, fixing the point *h* on the cross-line *f*.

Taking the cross-line *b* as the major axis, draw a half-ellipse through 2, and complete the ovoid figure by continuing the curve through *h* to *a*. This shape will give a much better form to the bulb than is obtained by using a complete ellipse, and will prevent the common fault of making the foot too tall.

There is now a gap in the curve of the figure on each side between the neck and the bulb. This must be filled by bringing out the neck curve above *g*, and leading it to join the ellipse tangentially. Round ends to the bottom rim and slightly rounded corners at the mouth complete the figure.

Fig. 2 is a sketch of the model placed below the eye. The most noticeable change is a more bulky appearance of the body of the vase. The same thing was noted in the vase figured in last month's issue, and this is always the case—the big round parts showing more and the thin parts less as the vase is tilted or seen in more angular directions.

One position (as in Fig. 2) will be enough for Standard VI. children. The work as before, but in addition refer back to "round rims," and call attention to the round rim at the foot, and the round edge at the opening of this vase. Show an inside line along the front portion of the lip, letting it die away as it turns round at the ends of the ellipse.

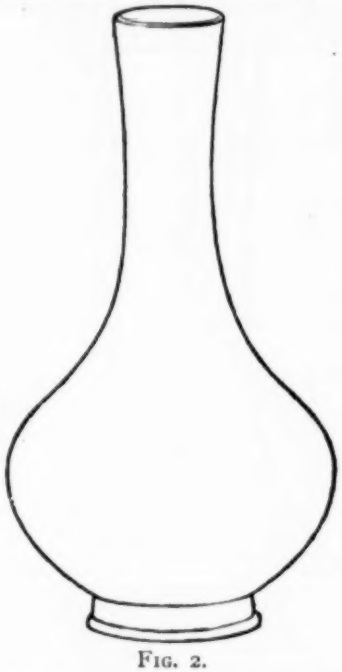


FIG. 2.

Get a glazed earthenware pot with curved sides, and let the pupils draw it, finding their own proportions and measurements.

NEW PROBLEMS IN ARITHMETIC.

(SECOND SERIES.)

BY T. B. ELLERY, F.R.G.S.,
President of the National Union of Teachers.

3RD PAPER.

STANDARD V.*

THE first series having been well received, and the Editor's wish being law, the present series is submitted in the hope that teachers—especially the young and inexperienced—may derive some assistance in their heavy labours.

As I have said before, a number of the exercises may be found beyond some of the children in the Standard, but each will form the basis of a good lesson, and the whole set, carefully worked on the blackboard and by the children, will give excellent practice and help considerably in the preparation for the work of the next higher Standard.

For introduction see *The Practical Teacher* for October 1894, and for further particulars *The Girls' Mistress* for September 1st, in which issue appeared the first of a series of papers entitled *Standard Problems for Girls, and How to Solve them.*

* Pupils in Standards VI. and VII. and Pupil Teachers will find these useful practice.

The second series began with a set of tests for Standard III.

A.

1. A exchanged 250 fowls at 2s. 9d. each with B for $5\frac{1}{2}$ dozen turkeys. Find the price of a turkey.

2. I bought 3 gross of pencils at $3\frac{1}{2}$d. per dozen, and 5 gross of pens at 3 dozen for 6d. I sold the pencils at a halfpenny each, and the pens at 4 a penny. Find my total gain.

3. One woman earns £31 4s. a year, and another woman earns £44 4s. in the same time. How much will one earn more than the other in 25 weeks? (52 weeks, 1 year.)

4. If 48 men can do a piece of work in 15 days, how many additional days must be allowed if the number of men be decreased by 8?

5. I buy 520 halfpenny papers at 4d. a dozen, and 325 penny papers at 9d. a dozen. (Reckon 13 to the dozen.) What change shall I receive from a five-pound note?

6. If 17 men can build a wall 34 ft. long in 8 days, how many would do the work in $4\frac{1}{4}$ days?

7. If a piece of carpet 30 yards long and $1\frac{1}{4}$ yd. wide cover a room, how wide is another piece, 50 yards long, which covers the same room?

8. I bought 6 dozen oranges at $\frac{3}{4}$d. each, and 9 dozen at $\frac{1}{4}$d. each. What did each 5 dozen cost me, taking one lot with the other?

9. If a wall, 60 yards long, is built in 15 days by 24 men, how long will 40 men take to build one twice as long?

10. A party of fifty-four persons went by excursion train, and the total cost of tickets, etc., was £18 19s. There were in the party 16 children who each paid 3s. 6d. What did each adult pay?

11. A man walked $112\frac{1}{2}$ miles in 6 days. On the first day he walked $18\frac{1}{2}$ miles, and on the second 20 miles. How many miles did he walk on each of the other days, taking one day with another?

12. A exchanged 30 tons of coal at 18s. per ton with B for 36 gallons of gin. Find the cost of a pint of gin.

B.

13. 24 horses or 156 sheep cost £429. What would you pay for 12 horses and 12 sheep?

14. A grocer bought $\frac{3}{4}$ cwt. of tea at £7 per cwt., and $\frac{1}{4}$ cwt. at 1s. 8d. a lb. He mixes the whole, and sells at 2s. a lb. Find his gain.

15. 6 horses and 20 sheep cost one hundred and eighty guineas. What will 13 horses and 10 sheep cost? (5 sheep = 1 horse.)

16. If 12 horses be worth 72 sheep, and 18 sheep cost £45, find the cost of 7 horses.

17. A grocer mixed chicory at 4d. per lb. with $\frac{1}{2}$ cwt. of coffee at 1s. 4d. per lb., and the total cost of the mixture was £3 16s. How many lb. of chicory were there in the mixture?

18. A man earns 16s. a week for 40 weeks of the year, and half as much again per week for the rest of the year. (52 weeks, 1 year.) His weekly expenses are 9s., and his year's rent amounts to £6 10s. What has he for other purposes?

19. A woman spent £5 in eggs at 9 for 6d. She sold them at a gain of 7d. per dozen. What did she receive for the whole?

20. £4 16s. is divided among 8 men, 10 women, and a certain number of children. Each child receives half a woman's share, and each woman half a man's share. A man receives 6s. How many children were there?

21. Jane had $\frac{1}{3}$ of a sum of money, Emily twice that amount, and Rose had as much as the two together. If Rose's share amounted to $2\frac{1}{2}$ guineas, what did Jane receive?

22. A woman bought a joint of meat, weighing 12 lb., for 7s. 6d. What would she have paid if the joint had been 3 lb. heavier, and the cost a halfpenny per pound more?

23. A gentleman spent £11 7s. in tables, chairs, and curtains. Each pair of curtains cost 7s. 6d., a chair cost 1s. more than a pair of curtains, and a table cost 11s. 6d. more than a chair. He bought 4 tables and a dozen chairs. How many pairs of curtains did he buy?

24. A wine and spirit merchant bought 54 gallons of whisky at 16s. a gallon. He mixes 6 gallons of water, and then sells the mixture so as to gain £22 16s. on the whole transaction. What did he charge per gallon for the mixture?

C.

25. 16 horses cost as much as 100 sheep; 20 sheep cost as much as 2 cows. If I pay £18 10s. for a cow, what is the cost of a horse?

26. A grocer bought a cask of sugar, weighing in all $2\frac{1}{2}$ cwt. (16 lb. for the cask), for £1 9s. 2d. He sold one-half at $1\frac{1}{2}$d. per lb., one-half of the remainder at $1\frac{3}{4}$d. per lb., and the rest at 2d. per lb. Find his gain?

27. A man bought 2,500 eggs at 1s. a score, and then 1,200 at 7d. a dozen. He threw away one out of every score, and he sold the remainder at a penny each. Find his gain.

28. Divide a guinea among A, B, and C, giving B 2s. 6d. more than C, and A 3s. 6d. more than B.

29. I spent £31 10s. in potatoes at half a guinea a sack. I sold the whole at thirteenpence a peck. Find my gain. (Reckon a sack as three bushels.)

30. A man pays £6 10s. each quarter of the year for rent, and his other expenses are 13s. a day (365 days, 1 year). He saves £78 a year. What is his weekly income? (52 weeks, 1 year.)

31. I bought butter at the rate of 16 lb. for a sovereign, and sold it at $9\frac{1}{2}$d. per half lb. My whole gain being £1 17s. 4d., what weight did I sell?

32. A fruiterer bought pears at 7d. per dozen, and sold them at $1\frac{1}{2}$d. each, gaining in all 10s. 8d. How many dozen did he sell?

33. If the income-tax be 8d. in the £, and nothing is paid on the first £160 of a person's income, what does a man pay whose total income is 300 guineas?

34. A man after paying 8d. in the £ income-tax has £696 remaining. What could he spend (or save) each month of the year (12 months, 1 year) if he had not paid income-tax?

35. The railway fares between one town and another 30 miles distant, are 1st class 2d., 2nd class $1\frac{1}{2}$d., 3rd class 1d. per mile. The company received on one day from passengers, travelling from the one town to the other, £120. £25 was received from the 1st class passengers, and there were 240 2nd class passengers. How many 3rd class passengers were there?

36. A publican spent £37 in brandy at 18s. 6d. a gallon. He sold the whole in bottles at 3s. 6d. a bottle. Find his gain. (6 bottles to the gallon.)

37. 24 boys and a certain number of men earn in all £3 10s. Each man's earnings (3s. 6d.) being three times a boy's, find the number of men.

38. 12 men can do a piece of work in 14 days. How long would 8 women and 12 boys take to do the same work, two women *or* 4 boys being equal to 1 man?

39. X had $\frac{1}{3}$ of a sum of money, Y had $\frac{1}{5}$ of that sum more than this, and Z had the remainder. If X's share was £5, find the share of Z.

40. If the 4d. loaf weigh 5 lb. when wheat is at 35s. what ought the 6d. loaf to weigh when wheat is 42s.?

ANSWERS.

(1) 10s. 5d.
(2) 12s. 6d.
(3) £6 5s.
(4) 3 additional days.
(5) £3 7s. 11d.
(6) 32 men.
(7) $\frac{3}{4}$ yard.
(8) 2s. 3d.
(9) 18 days.
(10) 8s. 6d.
(11) $18\frac{1}{2}$ miles.
(12) 1s. $10\frac{1}{2}$d.
(13) £247 10s.
(14) £3 12s. 4d.
(15) £283 10s.
(16) £105.
(17) 4 lb. chicory.
(18) £16 10s.
(19) £9 7s. 6d.
(20) 12 children.
(21) 17s. 6d.
(22) 10s.
(23) 6 pairs.
(24) £1 2s.
(25) £11 11s. 3d.
(26) 7s. $11\frac{1}{2}$d.
(27) £5 9s. 7d.
(28) A 10s. 2d.; B 6s. 8d.; C 4s. 2d.
(29) £7 10s.
(30) £6 11s. 3d.
(31) 1 cwt.
(32) 16 dozen.
(33) £5 3s. 4d.
(34) £60.
(35) 400 3rd class passengers.
(36) £5.
(37) 12 men.
(38) 24 days.
(39) £15.
(40) $6\frac{1}{4}$ lb.

AN INTERESTING OLD BOOK ON EDUCATION, BEING THOUGHTS ON EDUCATION.—By Bishop Burnet (1643–1715).

BY THOMAS CARTWRIGHT, B.A., B.SC. (LOND.),
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Evidence has ere now been adduced in these columns of the interesting and curious finds which will be the reward of the historian of education who ransacks the shelves of the Educational Library at South Kensington. It was whilst employed in this occupation that we happed upon the 'Thoughts' of Bishop Burnet, the which we to-day lay under contribution in the interest of our readers.

Gilbert Burnet, as all the world knows, was greatly instrumental in bringing about the accession of William III. and Mary II.; indeed he wrote the 'Declaration' which William issued on accepting the invitation of the English people to save them from

the ineptitude and tyranny of James II. As a historian Burnet is justly famed; the 'History of His Own Times,' which was published after his death in 1715, being both elegant in diction and redolent of shrewdness and sagacity. With this we are not now concerned. What does concern us is the fact that Burnet, who was rewarded with the bishopric of Salisbury for his adherence to the party of William, found time and had inclination for writing the curious little treatise on education which we are now considering.

Burnet's reason for posing as an authority upon pedagogics may perhaps be found in the fact that he acted as tutor to the Prince of Gloucester, and so became conversant with the personal side of the preceptor's art. Be that as it may, the MS. was printed in 1761 'for D. Wilson, at Plato's Head,' and the editor in his preface shows clearly that the handwriting of the MS. was that of the Bishop, and accounts for the delay in its being brought to light. 'It is plain,' writes the editor, 'from the contents, that this Essay was written at the desire, and for the use, of some very considerable personage about the year 1668, when the author, as he tells us, was not quite twenty-five years of age; having been born, as appears from his life, at Edinboro' in 1643.'

At the very onset we are met with the lament that the education of children is not looked upon as of first rate importance. 'O fathers, what doe you? so carefully to gather fortunes for your children, and so little to consider what they are to whom ye leave them. And upon good ground did the wise Theban, being asked in the school at Athens what were the causes of the ruin of a State, reckon one of the chief to be the neglect of the education of the youth. For since there is in view a natural byas and propensity to corruption, it is not to be doubted but ill-disciplined children will prove, for most part, dissolute and profligate men.'

A few pages further on we encounter the undoubted truth which is now being slowly appreciated by those responsible for public education, that the teaching work will stink in the nostrils of the people until it shall be customary to treat the teacher with consideration and respect. 'The two great causes of the penury of governours are these: first, the contempt that this employment is exposed to, they being held and treated as servants, which makes men of parts disdain it. Otherwise did Aurele the Emperor, who made his son's governour eat at his own table;: and Theodosius, who once found his sons' governour, Arsenius, standing bare while he was sitting, and ordered that in all time thereafter his sons should stand uncovered by him, and he sit covered. And as a more respectful way of treating governours would allure many to the employment, so it should conduce such to preserve in the youths respect towards their governours. In Athens we read that the noblest and best of that State were educators of youth—such as Socrates, Plato, Epicurus, and Aristotle. The like was also at Rome.

'Another reason of the penury of governours is the unworthy niggardness of parents, who grudge to give a considerable reward whereby they may be well maintained and encouraged. It is a frugality, the wisdom of which I cannot comprehend, to mesnage a youth's fortune at the loss of his education. What an inexcusable folly is it to see parents bestow largely for a horse to their son, and for grooms to dress him, and for trimming of his clothes and linnens, and yet stand upon a good salary for a discreet governour. Aristippus having counselled a father to see for a good tutor to his son, he was asked what would that amount to; he answered, a hundred crowns; the covetous wretch replied that such a sum might buy him a slave. "*Well*," said Aristippus, "*bestow your money so, and you shall have two slaves—the one your ill-bred son, and the other he whom you buy for your money.*" '

The acumen of the worthy bishop is again apparent in his enumeration of the qualities which should be the endowment of a preceptor who should satisfy our author:—'Wisdom and discretion is to be sought in the next place, without which even a good man will prove a bad governour if he have not the wise arts of gaining the youth's love, of tyming reprooffs, of insinuating precepts, and of moderating his corrections. A serene good nature is also a very necessary qualification for a governour, that by his moroseness he may not deterre the youth from his company, but by his sweet behaviour may make him delight in his conversation; yet with all this there must be joyned gravity, otherwise he shall quickly lose his authority; and, indeed, it is a rare compound to find a just mixture of douceur and gravity. . . . And, in the last place, I would chuse one of various learning. *I place this last, for indeed I judge learning the meanest part of education, and were it not that study preserves youths from idleness and worse exercises, I should not very earnestly recommend it to the breeding of all youths; for indeed the right framing of their minds and forming of their manners is most to be thought upon.* . . . But I would not have him one who hath made one science his whole study; for often confined students have straitned and narrow thoughts.'

Well may the margin of the book—the regulations of the library notwithstanding—be constrained to bear witness to the dubitation of a previous reader—'How few be these qualities!' How few indeed, re-echo we.

The next consideration is to inspire the 'governour' with a love of his pupil, 'for love and friendship are most forcible motives and attractives, which prevail more with ingenuous spirits than all fallerys. Having thus engaged him by true friendship, you shall be assured of his utmost diligence.'

In proceeding to deal with how the boy should be trained up, Bishop Burnet thus delivers himself: 'In the first place, the main care should be to infuse in him, early, a great sense of the Deity, together with a holy reverence for Scripture, joined to a high esteem of vertuous persones and actions, and as great a contempt of vicious ones.' Furthermore, diligent care is to be taken to inculcate a love of truth, and to eradicate the 'passion, malice, and pettish conceits.'

As to the way in which this moral education is to proceed, the Bishop is again decided, and his decision is just: 'Now all these vertues should be taught, not by mere precept, but by natural discourse; showing the excellence, sweetness, and advantage of them; and this will be best insinuated by examples brought either from history or experience.'

'As for letters, the first thing the Grecians and Romans thought on, was to teach their boyes the elegancies of their own tongue; for which end

every city was full of the schools of rhetoricians; and perhaps the neglect of teaching boyes the purity and propriety of their mother tongue, hath occasioned the great rudeness criticks judge our western languages to be guilty of.'

Still the Bishop will have nothing of logic and rhetoric—'all the difference betwixt these being that the one is reason in a court dresse, the other in a military garbe'; and he declares for Latin and French for the same reason that we of to-day are constrained to declare for German: 'Latine or French are these in which all learning is now to be found, and so one of these must be exactly known and understood.' But the clear-sightedness of Burnet as to what education really comprehends impels him to say that he will not force these languages upon a student having no aptitude therefor, seeing that 'he may be a knowing man without a word of it,' adding, 'and so I equally blame the French, who begin universally to neglect the Latine, and our own countrymen, who insist too much upon it, and give over the education of a boy for lost, if he goe not through with his grammaire.' Again, as to the learning of rules, sagacious counsel is given: 'There is no need for learning anomalys, or all particular rules, by grammarie; for *these are best taught by practice; and to force boyes to get so many barbarous rules by heart is to torture rather than to teach them.*'

Like the late Professor Blackie, our author would teach the dead languages by conversation, and he tells us that 'the reason why this excellent method is so little used, is because few masters have the abundance of Latin as to discourse promptly in it without study.'

The necessity of teaching geography in connection with history is also admirably appreciated and expressed: 'Now, for one apparatus to history, geography must be first discoursed of, and well illuminated instances must be got, which, as they will delight the boy, so will they help much to infix places in his memory.'

Again the writer points out a most important truth, which is not adhered to by many teachers of to-day, viz., that the more important features of a subject must be first insisted upon, the detail being left for a later stage in the lesson. 'In discoursing on geography and history, the method of painters is to be followed, who first draw the under draughts, and work the proportions; after filling them up with their true colours. In geography, therefore, all to be told at first going over is the names and divisions of the several states and kingdoms of the world; but when he goes to give the history of any nation, its government, chieffe rivers, provinces, and towns, must be remembered, not all at once, but as occasion offers in narrating the history.'

The vexed question of correctness of course receives attention; and albeit the author, in vetoing public correctness for boys of ten years and upwards, is not in accord with modern ideas on this subject, still the note that he sounds is tuned in the right key—'Kyndnes and love will alwaies prove the best charmes: even great faults, if the boy confesse them, and promise amendment, sould be pardoned, unless they be customary. Faults should be reproved kindly without passion.' '. . . if a child has any kyndnes or good nature, the sharpest punishment will be to carry coldly to him without any shew of kyndnes; and this, if continued in for a while, will sooner gall him than anything.'

Botany, music, drawing, and history are to be taken by way of recreation should the pupil exhibit any inclination for these subjects, so that 'even his idlest houres shall not entirely goe to waste,' and the boy is to be well exercised in the usual sports and pastimes of the period. Moreover, special pains are to be taken as the nature of the boy unfolds to repress vices, such as 'love of money, ambition, much talk, a valuing of one's selfe for their rank, title, friends, or parts; but chiefly rash and indiscreet censuring; and all these must be beaten downe by strong reason often repeated.'

Further counsels are given for the conduct of the pupil's training until the boy merges into the youth and the youth into the man; indeed, the whole period of life, from birth to the age of 25 years, is dealt with. Beyond this the writer opines it would be presumptuous to go, seeing that 'wanting yet some moneths of twenty-five, I should be grossly impertinent to give directions how to behave at one age, the experience whereof I have never had.' To follow further would profit us little, for we have extracted the gist of the embryo bishop's pedagogics, and we would fain believe that sufficient has been advanced to establish the reputation of Burnet as one who was ahead of those 'own times' about which he wrote so eloquently in the whole of his educational ideas, and abreast of our age in many of them. We shall therefore bring this sketch to a conclusion in quoting one of Burnet's concluding passages in which he so ably expresses the immense change in an individual that can be accomplished by a teacher skilled in his work: 'It will appear at first view that I have lent you rather a modell of what is to be wished than of what is practicable in educating youth; and that these are chimerique ideas. But if you once hit upon a wise governour, who is, I confesse, one in a thousand, you shall see the difficulty and not the following of these precepts is chimerique, and that even the dullest and most indocile boy may, by a cunning artisan, be made a polished man.'

MENTAL ARITHMETIC FOR THE STANDARDS.

BY T. B. ELLERY, F.R.G.S.,
President of the National Union of Teachers.

'*Mental work will strengthen the power of computation, and facilitate the handling of simple problems.*'—MR. CODD, H.M.I.S.

Second Paper.

INFANTS AND STANDARD I.—*Continued.*

IN our first paper we confined our attention to numbers not exceeding 12. The next step is numbers to 20. Our pupils must be led on to add, subtract, multiply, and divide, care being taken that that limit be not exceeded either in the working or in the answers. As before, coins, cubes, marbles, pencils, the ball frame, &c., &c., must be used, and used well. Be careful to show that 11 is 10 + 1, 12 is 10 + 2, 13 is 10 + 3, 14 is 10 + 4, 15 is 10 + 5, and so on. Let the children see this by concrete examples, let them perform the little operations for

themselves; in this way the lesson can best be driven home and remembered. Take the number 15, for example. By means of marbles we can show that 15 is 10 + 5, thus:

oooooooooo ooooo,

and many interesting operations can be performed.

Twos oo oo oo oo oo oo oo o
Seven *twos*, and 1 towards another *two*.

Threes ooo ooo ooo ooo ooo
Five *threes*.

Fours oooo oooo oooo ooo
Three *fours*, and 3 towards another *four*.

Fives ooooo ooooo ooooo
Three *fives*.

Sixes oooooo oooooo ooo
Two *sixes*, and 3 towards another *six*.

The applications of this are so numerous that I can but suggest a few of them. For example, let one of the boys take the fifteen marbles in his hands. Call upon him to give three marbles to one boy, three to another, etc. He will find that he can give three to each of five boys. Let him now give them away in *fives*. He will find that he can give five to each of three boys.

Addition— 3 + 3 + 3 + 3 + 3 = 15;
5 + 5 + 5 = 15.

Subtraction— 3 from 15 = 12;
6 „ 15 = 9;
9 „ 15 = 6;
5 „ 15 = 10;
10 „ 15 = 5;

and so on. 12 from 17. Write this on the board and show the children it is simply 2 from 7. Give many other examples similar in form.

Multiplication— 3 × 5 = 15;
5 × 3 = 15.

Division— 15 ÷ 3 = 5;
15 ÷ 5 = 3.

And, of course, these are specimens only. Perform the same operations with coins, and it will not be long before the children can see that there are five threepences in fifteenpence, that fivepence is contained in fifteenpence three times, that if each of three boys had fivepence given to him the amount distributed would be fifteen pence, and so on. One operation will suggest another. Do not be in a hurry to 'go on!' When, say, 15 is well known (and your 'experiments' must include 7 and 8, 9 and 6, 5 and 10, 4 and 11, etc., etc.), you can deal with 16 in similar fashion.

Addition— oooooooooo oooooo
Also 8 + 8 = 16;
4 + 4 + 4 + 4 = 16;
10 and 6 are 16;

and, leading on from this, 9 and 7 are 16. (It will be a comparatively easy matter to show that 9 + 7 gives exactly the same result as 10 + 6). These are but suggestions; scores of other operations will readily occur to the painstaking teacher.

Subtraction—
10 from 16 = 6; 6 from 16 = 10.
8 + 8 = 16, ∴ 8 „ 16 = 8;
9 + 7 = 16, ∴ 9 „ 16 = 7.

Multiplication—Give 4 nuts or pencils to each of four boys, then 2 to each of 8 boys, 8 to each of 2 boys.

Division— oooo oooo oooo oooo
oo oo oo oo oo oo oo oo
oooooooo oooooooo

Multiplication and Division can thus be taught at one and the same time (as with Addition and Subtraction).

Thus 4 × 4 = 16; 2 × 8 = 16;
16 ÷ 4 = 4; 16 ÷ 2 = 8;
and 16 ÷ 8 = 2.

Then with *coins*. Your pupils will soon *see* that with sixteenpence I can give 2 pence to each of eight boys, or 8 pence to each of two boys; that, out of sixteenpence, I can give threepence to each of 5 boys, and have one penny remaining, etc., etc.

And in this way we reach 20—

oooooooooo oooooooooo
ooooo ooooo ooooo ooooo
oooo oooo oooo oooo oooo
oo oo oo oo oo oo oo oo oo oo

The above will suggest several 'operations,' and the thoughtful teacher will not be slow to discover many others.

As before, keep the money table well in hand, never exceeding 20, of course. Let the farthings table be well known.

4	farthings	1d.	2	halfpence	1d.
8	„	2d.	4	„	2d.
12	„	3d.	6	„	3d.
16	„	4d.	8	„	4d.
20	„	5d.	10	„	5d.
			12	„	6d.

to 20.

s. d.
Twice 6 is 12 = 1 0.
„ 7 „ 14 = 1 2.
to „ 10 „ 20 = 1 8.
Three times 4 is 12 = 1 0.
„ „ 5 „ 15 = 1 3.
„ „ 6 „ 18 = 1 6.
Four times 3 is 12 = 1 0.
„ „ 4 „ 16 = 1 4.
„ „ 5 „ 20 = 1 8.

Ten shillings = half a sovereign. Twenty shillings = £1 (a sovereign).

In a sovereign are ten *florins* (two-shilling pieces), five *four-shilling pieces*, four *crowns*, eight *half-crowns*.

In 10s. there are 20 sixpences.

All this must be taken a step at a time, so that many lessons will be necessary if the course is to be thorough. The limits of space prevent any further attention to such details here. I pass on to mental exercises to 20, all of which are suggestions only. A score of 'operations' can easily be based on each of those here given.

1. Add 10 and 2, 10 and 4, 10 and 5, 10 and 6.
2. Add 8 and 4, 8 and 5, 8 and 6.
3. Add 10 and 10, 10 and 7, 9 and 8, 8 and 9.
4. Take 10 from 14, 4 from 14.
5. Take 8 from 14, 8 from 15, 8 from 18.
6. Take 7 from 17, 10 from 17, 7 from 13.
7. Add 4, 3, 6, 5.

8. Add 2, 5, 9, 3.

9. What is the sum of 3, 7, 6?

10. Tom had 5 apples, Harry had 7, and Fred had 6. How many had they altogether?

11. I had 14 nuts. I gave 4 to Mary and 7 to Jane. How many left?

12. I gave 3 pens to each of 3 boys and had 6 left. How many had I at first?

13. I have 17 nuts in my pocket. How many would remain if I gave away 12?

14. There are 18 apples on a plate. If I give them to 6 boys, an equal number to each, how many will each receive?

15. Add 7 to 3 times 4.

16. Add half a dozen to five times 2.

17. Take four from six times 3.

18. What must you add to 3 times 5 to make 20?

19. How many half-dozens are there in 18?

20. Add 9 and 7; 10 and 9; 5 and 12.

21. Take 11 from 15 and add your answer to 12.

22. I give 2 apples to each of 4 boys and 5 girls. How many do I give away?

23. How many fives are there in 15? in 20?

24. If I give 4 pence to each of 4 boys, what will be left out of eighteenpence?

25. Take 14 from 20 and divide the remainder by 2.

26. Take half a score from 18.

27. How many steps, each 2 feet, would you take in walking 18 feet?

28. Add twice four to three times 3.

29. Take three times four from a score.

30. I give 2 apples to each of 3 boys, and 3 apples to each of 4 girls. How many do I give away in all?

31. How many sixpences in a shilling? in eighteenpence?

32. How many fourpences in 1s. 4d.? How many threepences in 1s. 3d.?

33. How many pence in 1s. 6d.? How many halfpence in 6d.? in 10d.?

34. How many florins in sixteen shillings? in a sovereign?

35. I gave 6d. for a book. How many could I buy with 5s.? with 7s. 6d.?

36. I give a penny to each of fourteen boys. How much left out of 1s. 8d.?

37. A man gave 3 shillings to each of five men. How much left out of a sovereign?

38. Take 2d. from 6d.; 4d. from 10½d.; 3½d. from 6d.

39. To how many boys can I give ½d. out of 9d.? out of 7½d.?

40. Take sixteen farthings from sixteen pence. Take 8d. from a shilling. Take 8½d. from 1s.

41. How many fourpences in 1s.? How many twopences in 1s. 8d.?

42. I bought 5 slates at 3d. each. What change from 1s. 6d.?

43. I gave ½d. to each of 6 boys and 8 girls. How much did I give away?

44. From 6½d. take 18 farthings.

45. A boy saves ½d. a day. How long will he take to save 5d.? 9d.? 9½d.?

46. How many farthings altogether are there in the sum of 2 pennies, 2 halfpennies, and 2 farthings?

47. How many pence in 1s. 2d.? 1s. 5d.? 1s. 7d.?

48. Divide 18 halfpennies equally among 5 boys and 1 girl.

49. Find the cost of 18 articles at a penny each; 15 at a halfpenny each; 20 at a farthing each.

50. I buy 16 apples at a halfpenny each, and a dozen pens at a farthing each. How much do I spend?

CONVERSATIONAL LESSONS IN CHEMISTRY.

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For particulars of the List of Chemicals and PRACTICAL TEACHER Set of Apparatus for working the experiments referred to in these lessons see numbers for January and February 1893.

LESSON XXIII.—GOLD.

OUR lesson to-day will have for its subject the only yellow metal in existence. What is that, Walter? Brass, sir. Ah, you have made a mistake, my boy, which you must correct. I remember now, sir, that brass is not a metal, but an alloy. Yes, Winnie shall tell us of what it consists. It is a mixture of copper and zinc, sir. Very good; and now, Walter, what is our yellow metal? It is gold, sir. Very true, and where is gold found? Mainly in Australia, California, and Africa. Quite right; I daresay most of you have read of the recent rush to the gold diggings of West Africa. How is gold found? Is it not found pure, sir? I suppose you mean that it occurs free and uncombined, and in that you are right; but frequently it is anything but pure, being associated with silver, copper, or lead. Here is a specimen of the rock in which gold usually occurs. It is the familiar quartz. In order to get the gold the rock is (1) crushed, (2) washed, (3) picked, and (4) amalgamated. What do you mean by amalgamated, Eva? Mercury is added to the gold, with which it at once alloys, and from which it is readily separated by heat, which drives off the mercury as vapour, leaving the gold behind. Well, Annie, what do you wish to know? What is meant, sir, by gold dust being found in the beds of rivers, as in the West of Africa? The gold-bearing quartz is broken up by water or by other agents of disintegration. The grains of gold are then washed away and deposited in the sand of the beds of rivers. From this it is separated by washing, the sand being carried away by a rapid flow of water. Why is the gold not carried away, Lilla? Is it because it is much heavier than the sand in which it is deposited? Yes, and from this you will readily remember that gold is a very heavy metal; how heavy you will gather from the fact that whereas the specific gravity of iron is about 7, that of gold is 19—in other words, gold is about three times as heavy as iron. What else can you tell me concerning this precious metal? Perhaps you can explain, by the way, why it *is* precious. Because it is rare, sir. Yes, and also because it is very beautiful and therefore valued for ornaments. But it is nothing like so useful as the more homely iron. Why? Because it is so soft, sir? Before we go any further, I should like you to tell me how you know that it is soft. I can do that, sir; we cannot use pure gold either for ornaments or for coins on account of this softness. That is quite so, gold coins and gold ornaments are usually made of an alloy of gold and copper, more or less rich in gold. How do we express the relative proportion of gold used in any specimen of the alloy?

I see you do not understand me, so I will put my question in another form. How does the jeweller describe the various qualities of his golden wares? You, Phil, shall answer. We speak of them as 9 carat, 15 carat, 18 carat, 22 carat, etc. Do you think you can go above 22 carat? You do not know, so I will tell you that we take 24 parts of the alloy and then express how many of these are pure gold; therefore 15 carat means that 15 parts out of 24, or $\frac{15}{24}$, of the whole is pure gold, and 9 parts, or $\frac{9}{24}$, of baser metal. Now, Charlie, how should we express pure gold on this method. Pure gold would be 24 carat, would it not, sir? Exactly, but let us see what Harry has to say. What does the word carat mean, sir? It really means 4 grains, but is almost invariably used now-a-days in the special sense of describing how many parts in 24 parts of alloy are pure gold. Tell me, now, why gold should be valued for ornaments more than other comely metals. It wears better, sir. Yes, but you must explain a little more clearly what you mean by 'wearing.' It keeps its colour for so long and does not rust. But what is rusting? Is it not chemical combination, sir? Yes, and generally combination with oxygen, *i.e.*, oxidation. You may, therefore, safely infer that gold is not acted upon by oxygen, nor indeed by other bodies. No single acid will corrode it, for which reason it is one of the 'noble metals,' which can only be acted upon by what, Charlie? No answer. Come now, think; 'noble' should easily suggest 'kingly,' the Latin for which you know, and the acid—or rather mixture of acids—which is able to dissolve gold is called the 'kingly liquid,' or '*aqua regia*.' Here is a specimen of gold leaf. See, I put it in hydrochloric acid, and another portion in nitric acid. I heat, but, as you can readily observe, in neither case is there any action. I place the two acids together, and immediately chemical action is evident. Now, Maud, what is *aqua regia?* Do not hesitate, but say what you think. Is it not a mixture of hydrochloric and nitric acids, sir? Of course it is, and I may as well tell you at once that the compound formed is gold chloride, of which here is a specimen in a sealed tube, in which form it is sold to photographers, who use it to 'tone' their pictures. Just now we mentioned gold leaf, and I am sure this brought to your minds a most important property of gold. James shall tell us what that is. Do you mean its malleability, sir? Yes, I do; for gold, besides being soft, is exceedingly tenacious, and can be hammered into films the thickness of which is not more than $\frac{1}{282000}$th of an inch. So thin are they as to permit the passage of light through them, the light so transmitted being of a greenish tint. These films are used in gilding letters, picture-frames, etc., an operation which some of you have probably seen performed by the sign writer or gilder. Besides being so wonderfully malleable, gold is just as marvellously ductile; an ounce of gold could be drawn out into wire five miles long. How is plating done, sir? Exactly in the same way as silver-plating. One of the poles of a galvanic battery is of gold, the other is constituted by the metallic body to be coated: both are placed in a solution of gold cyanide; this the current decomposes, the gold being deposited on the article required to be plated. This displaced gold is replaced by a portion of the gold spoken of as constituting one of the poles, and so the process continues until the layer of gold is sufficiently thick for the purpose in hand.

Now let me draw your attention to the beautiful purple colour on this porcelain cup. You would hardly guess that gold is the foundation of the pigment used in the production of this tint. Yet such, indeed, is the case, for this *purple of Cassius*, as it is called, is simply a compound of gold, tin, and oxygen, the exact composition of which is not known.

In conclusion, let us sum up the chief properties of this yellow metal. Perhaps Mary will try to put them in concise form:—

Gold is a yellow metal found free in quartz rocks. It is very heavy, and is not corroded by any single acid, although it is dissolved by aqua regia. It is extremely malleable, ductile, and tenacious. Because of its rarity it is precious, and is used (alloyed with copper) in the manufacture of ornaments and coins, also for gilding, plating, for toning photographs, and in the production of a valuable purple pigment.

NOTES AND NOTIONS.

BY RICHARD WADDINGTON.

THE Circular issued by the Education Department leaves no doubt as to the intention of the Department on the question of the use to be made of Art. 84. No longer will 'Examinations be botherations' if teachers and inspectors rise to the full liberty that lies before them. So distrustful have the teachers become of the Department and its officials that it will take much time to bring realisation. The teacher is to be really and truly king or queen within the four walls of the school. No longer is the inspector to be engrossed tabulating the number of errors in spelling in this class or that, or the number of sums correct per child throughout the school, but he is to be the guide and counsellor of the teacher. Bereft of statistics, and forced to trust to knowledge that comes of living contact with methods, there is great scope before the inspector who is full of the milk of human kindness. The Blue Book of the future ought to be a much more interesting document than it has ever been in the past.

> 'But as some muskets so contrive it
> As oft to miss the mark they drive at,'

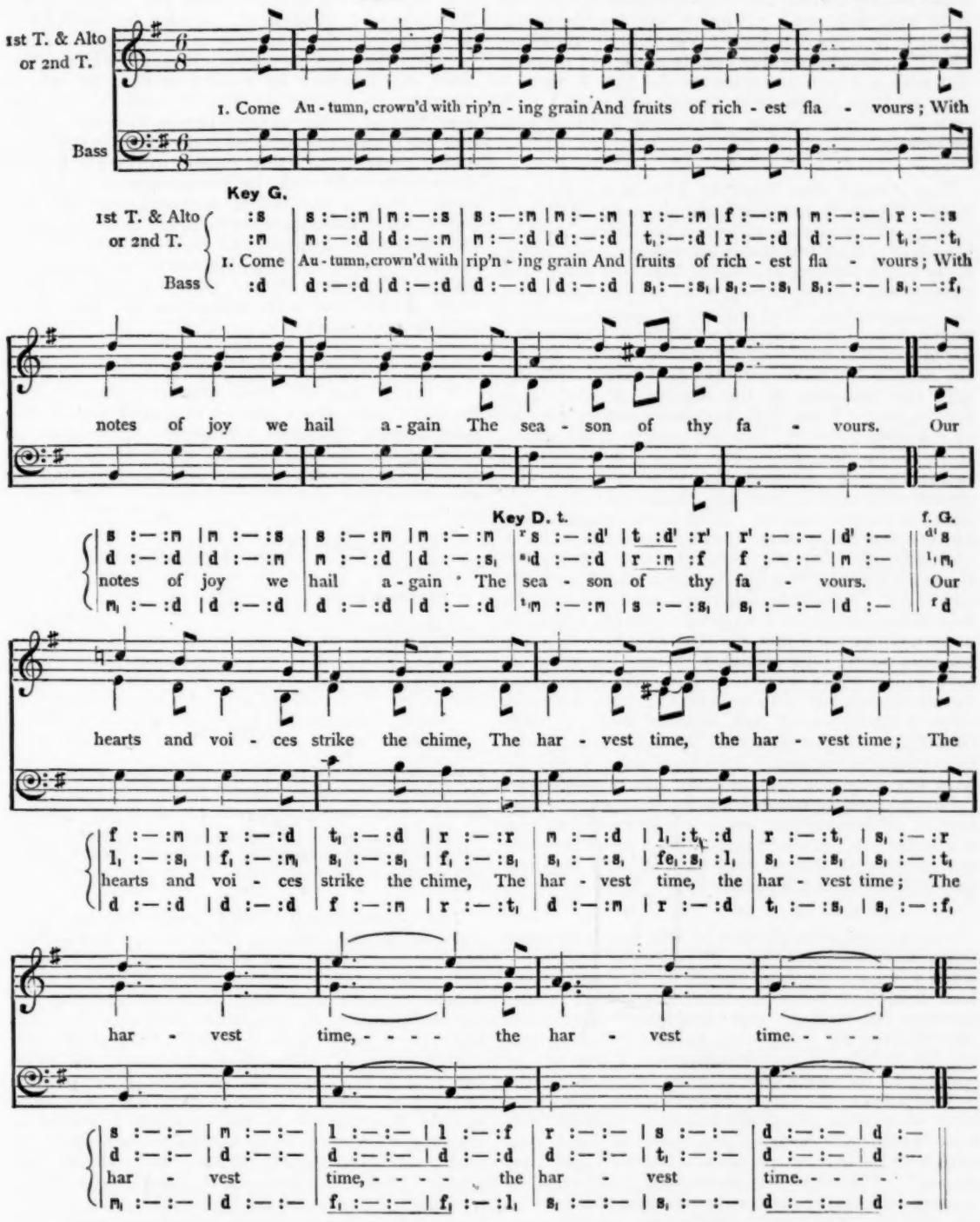
so we may expect some inspectors to fail to rise to the occasion. But for teachers and taught 'there's a good time coming.' If teachers are but courageous and anxious to give full vent to their newly acquired powers, a few years hence the teachers will wonder how they could have so long borne the cast-iron system. Think of the old days of the 'Exemption Schedule,' when inspectorial optics saw the list grow with frowning brow—when teachers feared to do right by the scholar, lest professional ruin, in the shape of a low percentage of passes, was their lot. Who would go back to the penny per cent. system—the most uneducational and cruel system that has been tried on the schools of the workers? Can we wonder if schools and inspectors do not rise to the occasion when we remember the bitter experience through which many have passed? That the inspector is no longer to examine the school seems hardly credible. 'It is too good to be true' is the verdict of hundreds of teachers. An inspector without his test-cards and piece of unseen dictation will be a novelty too grievous to be borne for a time. Teachers may be forgiven for exclaiming—

> 'Thou com'st in such a questionable shape
> That I will speak to thee.'

* * * * *

THE other day I was talking to one of my old boys who attends the Manchester Grammar School. No thoughts of the 'Spectre' haunted his studies. His aim was to master the work of his form, in order to obtain promotion to the next form. If he took six months for the task, well and good; he was duly promoted; but if he took two years he had to master the lower form work before he reached the higher. Why should not this obtain in our Primary Schools? It is more necessary in the Primary Schools. And under the New Code it is possible. Drop the word standard and let us have classes. The standard has too many baneful associations in the mind of both

HARVEST TIME.

Music by T. CRAMPTON.

1st T. & Alto or 2nd T.
Bass
1. Come Au - tumn, crown'd with rip'n - ing grain And fruits of rich - est fla - vours; With
Key G.
notes of joy we hail a - gain The sea - son of thy fa - vours. Our
Key D. t.
f. G.
hearts and voi - ces strike the chime, The har - vest time, the har - vest time; The
har - vest time, - - - - the har - vest time. - - - -

2. The harvest sun how bright at noon,
His richest radiance throwing!
And softly bright the harvest moon
With silv'ry light is glowing.
Then let us joyous strike the chime,
The harvest time, the harvest time;
The harvest time, the harvest time.

3. Our land is fertile, and our soil
Yields us these gifts possessing,
And all enjoy the harvest time
That makes each gift a blessing.
Then let our hearts and voices chime,
The harvest time, the harvest time;
The harvest time, the harvest time.

teachers and taught, to say nothing of the parents. Let us begin a new era. An era in which the child is the moving spirit. Let us do what is best for the child and 'fear not.' 'What is best for the child' ought to henceforth replace 'What will the inspector like?' I know this needs a certain amount of courage. But with a Union as strong as the N.U.T. there is little to fear. If teachers would only realise their own power, much might be wrought that now goes by default.

* * * * *

THE Annual Blue Book on Education is again to hand. There is not much that is new. The percentage of attendance improves but slowly, and the length of school life shows no rush upwards. Still, there is a steady improvement; slow, but sure. But there is one feature that ought to be carefully noted by every teacher. The number of persons qualified under Art. 68 exceeds 10,000, while in 1891 it was about half that number. Of course, the exaction of the Scholarship Examination as the final examination, with the limitation of the number of trials to a couple, would, in any case, have increased the number of "women over 18," but the growth is abnormal. It is partly due, there can be no doubt, to the increased staff requirements. The demands for greater teaching power are being met from the cheapest possible source. With these figures before him one wonders at Mr. Acland, educationist as he is, extending this class of teacher to boys' schools. If the small schools were not generally mixed schools where Art. 68 abounds, one might have seen the aim even if the folly was still as great. But the extension of Art. 68 in the Code for 1895 will lead to many teachers more fully qualified being replaced by women over 18—a result that even Mr. Acland can hardly contemplate with equanimity. All the good effect of the increased staff required next year will be nullified by the increased opening given to the least qualified teachers. The good schools already have the increased staff, and the others will obtain the extra teaching power from the cheapest possible source. Whatever may be the advantages of women as teachers of the lower standards, it can hardly be contended that they should be less than the best qualified before employment.

* * * * *

THERE is one other feature of this year's statistics that is unpleasant reading. A couple of years ago, when a deputation from the N. U. T. waited upon Mr. Acland on the effect of Art. 73, which divides teachers into 'trained' and 'untrained,' Mr. Acland regretted the use of the terms as in no sense expressing the opinion of the Department. I was unwise enough to take that platitude as an omen of Mr. Acland's desire to redress the grievance. But I have been once more practically taught to 'Put not your trust in princes.' Year by year the Blue Book contains two heads for teachers—'trained' and 'untrained.' It is time this matter was dealt with. It surprises me that not a word is ever said about this in the presidential address at Conference. Nearly every topic under the sun has been dealt with, but one looks in vain for outspoken and righteous indignation on this subject. Let us hope Mr. Macnamara will seize the opportunity at Brighton—the protest will come none too soon.

'Do you put away the inkwells every night?' was the query of one of Her Majesty's Inspectors. 'No,' was the teacher's reply. 'Then you ought to,' was the rejoinder. What next? Under Instruction 3 of the new Code the inspector is called upon to note 'whether the room is properly cleaned, warmed, and aired, the furniture in good condition, *the inkwells stowed away out of the dust*, and the water supply properly laid on.' But no sane person ever anticipated that the inkwells were to be collected and distributed daily. Only the practical teacher working in a large school fully realises the ludicrous nature of such a request. It is a pity, before harassing teachers with such queries, the inspectors do not take the trouble to consult the Department as to their intention in such matters. There can only be worry and anxiety so long as Inspectors devote their energies to such small details that only aggravate the difficulty of visits without notice.

* * * * *

A RETURN has just been prepared showing how far the Continental countries that took part in the International Congress at Berlin have gone in carrying out the suggestions made by that Congress. The report must be unpleasant reading for the supporters of early child labour. The age at which children may work is given as follows:—

Switzerland, Austria	Prohibited below 14.
Germany	" " 13.
Holland, France, Russia, Belgium	" " 12.
GREAT BRITAIN, Italy	Below 12.

It will be remembered that the Congress agreed that no child below twelve should work, and that Great Britain was strongly averse to allowing Italy to adopt a lower age. What a picture! Great Britain allied with Italy in sending young children into the factories.

* * * * *

THE School Board Clerks' Conference at Leeds was held as usual during Whit week. The advent of intermittent inspection would appear to have disturbed the School Board official mind. That there should be some misgivings causes no surprise, and especially when we remember that the Triennial Reports of many School Boards have been mere compilations of percentages, amount of grant earned per head, and all the other paraphernalia of the past, the regret at parting with the fixed Annual Examination is not so much a matter of surprise. The pity is to see ex-teachers like Mr. Gaunt of Huddersfield failing to welcome the advent of better conditions and greater trust in the teachers. The paper by Mr. Rothwell, the Clerk to the Bolton School Board, is both opportune and incisive. Mr. Rothwell knows the half-time problem from a life of close connection. He has spent his life in contact with the problem, and he is none the less sparing in his use of strong language in describing the selfishness of many of the parents. Mr.

Rothwell's paper ought to make the operatives that are opposing 12 years of age pause, if there is any humane instinct left.

* * * * *

THE progress of the Grand Committee on Trade with the Factory Bill and the ruling of Mr. Stuart Wortley that Mr. John Burns' addition to clause 14 raising the age to 13 for half-time employment must be raised at the 52 clauses in the Bill have been dealt with postpones the question for at least a couple of weeks. When the question is reached there is little doubt of the age being raised to 12 in the Grand Committee. And when the composition of the Grand Committee is taken into account this must be acknowledged to be a very satisfactory result. From a week in and about the House of Commons and the Grand Committee my confidence that the demand for improved conditions for the child worker is meeting with the support it is entitled to is increased. It is perhaps too much to hope that there should be no opposition, but so far as I can see, the opposition is extremely feeble.

* * * * *

THAT the N.U.T. is a good investment as an insurance against legal troubles must be recognised even by the non-unionist. Here are two cases just fresh from the hands of Mr. Organ. A manager and his wife circulate statements concerning the work of the teacher which are libellous. The N. U. T. takes up the case. Result: Apology tendered and case withdrawn with nominal damages assessed at 40s. and costs. This will mean over £250 for the manager. Second case—A student in training in November accepts an appointment as head teacher to commence the following January. For some reason the managers inform the teacher before commencing that his services will not be required. Teacher is unable to get a post for a month. Law Committee sued for salary in lieu of notice. Result: £12 10s. 0d. paid into court three days before hearing.

NEW COMPOSITION STORIES.—STANDARD V.

Suitable for 'Unseen Tests' in Reading also.

334.

A POLITE PUSSY.—A member of the Zoological Society says:—'I once had a cat which always sat up to the dinner-table with me, and had his napkin round his neck, and his plate and some fish. He used his paw, of course, but he was very particular, and behaved with extraordinary decorum. One day he was not to be found when the dinner bell rang, so we began without him. Just as the plates were put round, puss came rushing upstairs, and sprang into his chair with two mice in his mouth. Before he could be stopped, he dropped a mouse on to his own plate and then one on mine. He had divided his dinner with me, as I had divided mine with him.'

335.

AND HE WON.—A sporting gentleman, who had the reputation of being a very bad shot, recently invited some of his friends to dine with him. Before dinner he showed them a target painted on a barn door, with a bullet right in the bull's-eye. This he claimed to have shot at a thousand yards distance. As nobody believed him, he offered to bet the price of an oyster supper on it, and one of his guests accepting the wager, he produced two witnesses, whose veracity could not be doubted, to prove his assertion. Since they both stated that he had done what he claimed, he won his bet. During dinner the loser of the wager inquired how the host had managed to fire such an excellent shot. The host answered—'Well, I shot the bullet at the door at a distance of a thousand yards, and then I painted the target round it.'

336.

INVISIBLE INK.—Quite a dramatic story is told of the General Post Office, concerning 'invisible ink.' A postman had long been suspected of stealing sheets of postage-stamps, but the crime could not be brought home to him. One day he was found with a square foot or two of them in his possession and confronted with his official superiors. He maintained, as on former occasions, that he had bought them for his own use. 'What! these?' exclaimed his chief, at the same time passing a moist brush over one of the sheets, whereupon the blood-red words, 'Stolen from the General Post Office,' started out like a flame upon it. The ingenious chemical contrivance at once brought the thief to his knees.

337.

HUNTING IN A NOVEL FORM.—It is, of course, well-known that tame elephants are trained to help in the capture of wild ones, but it may surprise some people to learn that, in the Southern States of America, tame turkeys have been trained to hunt wild ones. If a hunter is patient enough to teach a tame turkey, he can take it to the woods, and when it gives out its call there will be an answering note from any wild turkey within hearing. The wild bird will advance very cautiously, as he is a suspicious creature; but, when he sees the turkey, his fears are gone, and he starts at once to do battle. Then the trained turkey runs, and the hunter shoots. There are advantages in this method. Some men can imitate a turkey-call very closely, but the bird makes an accompaniment by striking the ground with the wings. A hunter cannot reproduce this, and without it the game is suspicious.

338.

SAVED BY HUNGER.—On the 5th January, 1791, a party of five officers of a garrison went to skate on the moats of the town, which at that time were very deep. When it struck five, one of them, a young lieutenant of artillery, exclaimed—'Five o'clock! I must go to dinner!' 'Oh, stay a little longer!' begged his comrades. 'No, I am famished!' The others continued their pastime, but suddenly the ice broke, and the whole four were drowned. The fifth, whom hunger had driven home, was young Bonaparte—afterwards Emperor Napoleon I.

339.

PAT VICTORIOUS AGAIN.—An Irishman, having lost all his money at the gambling table, thought of a plan by which he could obtain as much as he had lost. He borrowed a pistol, and started forth on the highways. The first person he met was a middle-aged gentleman. Pat, going up to him, pointed the pistol at his head with—'Your money or your life!' The gentleman, evidently thinking himself a match for Pat, replied—'Hand me your pistol and I will give you my money.' Pat agreed, and the exchange was made. 'Now,' said the gentleman, 'give me back my money, or I'll blow your brains out.' 'Blaze away, my hearty,' shouted Pat; 'I niver put any powder in it.'

340.

IN HER OWN COIN.—A certain lady, who wished to have some fun at the expense of an agent who had oft-times solicited her to insure herself and family, asked him on one occasion if he would insure the cat. The agent, to the astonishment and no small amusement of some friends, promptly offered to do so, provided she paid the first premium down. The lady, still thinking to hoax him, expressed her willingness to do so, and placed a shilling on the table. The agent quickly produced a proposal, filled it in, and obtained her signature. 'Now, madam, with your permission, may I see the cat?' 'Certainly,' she replied, at the same time pointing to a glass case which contained the stuffed remains of the poor defunct cat. A chorus of derisive laughter burst from all present, but to their dismay, the agent turning, bowed politely, at the same time picking up the shilling, exclaimed—'When that cat dies, madam, kindly call at the office and claim the insurance money. Good morning.'

341.

SELF-SACRIFICE.—In the Bodleian Library at Oxford is a most affecting record of heroism and self-sacrifice on the part of a child—a record to touch one's heart with its pathos. The tower door of St. Leonard's Church, Bridgeworth, which at the time was undergoing repairs, was left open, and two young boys, wandering in, were tempted to mount a lofty scaffolding, and scramble from beam to beam. All at once a joist gave way. The beam on which they were standing became displaced. The elder had just time to grasp it when falling, while the younger, slipping over his body, caught hold of his comrade's legs. In this fearful position the poor lads hung, crying vainly for help, for no one was near. At length the boy clinging to the beam became exhausted. He could no longer

support the double weight. He called out to the lad below that they were both done for. 'Could you save yourself if I were to let go of you?' replied the little lad. 'I think I could,' returned the older. 'Then good-bye, and Heaven bless you!' cried the little fellow, loosing his hold. Another second, and he was dashed to pieces on the stone floor below. His companion succeeded in clambering to a place of safety.

342.

A PLEASANT ENDING.—A gentleman was travelling from London to Manchester, and, being fond of his pipe, entered a smoking compartment. At the first stoppage a well-dressed lady entered, carrying in her arms a little dog. When the train started off, she noticed that the gentleman was smoking, and told him to put out his pipe. 'Oh, no,' said the gentleman; 'this is a smoking carriage. I came here to smoke, and smoke I will.' This so vexed the lady that she snatched the pipe from out of the gentleman's mouth, and threw it out of the window. The gentleman coolly got hold of the little dog, and threw that out of the window. The enraged lady now screamed for the guard. But just then the train steamed into the station. As soon as the train stopped, the lady charged the gentleman with killing her dog. He in turn charged the lady with the loss of his pipe. The poor guard looked first at one and then at the other, not knowing what to do, when, just then, lo! the little dog came running up the platform with the pipe in its mouth.

343.

HONESTY THE BEST POLICY.—A man was paying his bill at the fishmonger's, and whilst the latter was making it receipted—with his back turned—the man slipped a codfish into his coat-tail pocket. But the garment was too short to cover up the theft. 'Now, Mr. Salmon,' said the customer, 'I have traded with you a good deal, and have paid you up promptly, haven't I?' 'Oh, yes,' was the reply, 'I make no complaint.' 'Well,' says the customer, 'I always insisted that honesty is the best policy, and the best rule to live by and die by.' 'That's so,' replied the fishmonger, and his customer turned to depart. 'Hold on, friend,' said the fishmonger, 'speaking of honesty, I have a bit of advice to give you. Whenever you come here again, you had better wear a longer coat, or steal a shorter fish!'

344.

THE JOKE DIDN'T WORK.—A man at a Glasgow hotel in a loud tone of voice called his friend back just as he was leaving the dining-room, and then whispered to him—'How far would you have got if I hadn't called you back?' The other, straightening himself up, replied in a tone loud enough for all to hear—'No, sir, I won't lend you five pounds; I haven't got it on me, and if I had I wouldn't let you have it until you have paid me what you borrowed two months ago.' His friend will never call him back again in a public dining-room.

345.

SINGEING A SHEEP'S HEAD.—During a certain frost in Edinburgh, a boy was holding a lighted candle for his master, a plumber, who was doing some repairs to a water-pipe. Being a little careless, the boy put the candle too near his master's head, and up went his hair in a blaze. Turning round in a great rage, his master exclaimed—'You stupid idiot, can't you look what you are doing? The folk of the house will be thinking we've been singeing a sheep's head because of the smell you have set up.' 'Well,' returned the boy, sulkily, 'they'll perhaps not be very far wrong.'

346.

CONFISCATED.—An excellent story is told of a British soldier who was serving in Egypt. His colonel, observing him one morning wending his way to camp with a fine Egyptian rooster in his arms, halted him to know if he had been stealing chickens. 'No, colonel,' was the reply, 'I just saw the old fellow sitting on the fence, and I ordered him to crow for old England, and he wouldn't, so I confiscated him for a rebel.'

347.

BITING THE BITER.—At Glasgow, not long back, a gentleman got into a wrong omnibus, and immediately got out of it into another. The conductor of the first omnibus followed the gentleman, and insisted on being paid. This demand, the gentleman, after some short parley, reluctantly complied with. The conductor, chuckling over his triumph, was making the best of his way out of the omnibus, thinking, no doubt, how well he had done it, when he was stopped at the door by the other conductor for his fare and had to pay.

348.

SHREWD.—A shrewd man, who keeps a toy-shop in a seaside town, has advertised his wares in an unique way. He noticed that strangers who came there invariably amused themselves by walking along the beach and picking up shells: so he procured a waggon-load of mussel-shells, and upon their white interiors stamped in red ink an advertisement of his business. Every morning he sent out a boy with a basketful of these small circulars, to distribute them along the sandy promenade. The visitors eagerly picked them up, and the toy dealer's ingenuity was rewarded by frequent calls for children's shovels, pails, and other toys.

349.

THE GROCER OUTWITTED.—A Glasgow grocer was talking in his shop to two or three customers, when a blind man entered and solicited alms. The grocer, who was disposed to show his superior knowledge of human nature, remarked:—'Have you noticed, my friends, how very delicate is the touch of a blind man? I always think Providence has made up the loss of one sense by making one of the others more acute. Now just see how this poor man can tell a thing by the touch,' and, putting some fine sugar in a scoop, he held it out to the beggar, remarking, 'What's that, my man?' The blind man extended his hand, took a pinch between his finger and thumb, and, without any hesitation, said, 'That's sand!'

350.

WHEN MOST NEEDED.—At the entrance of a certain building is a placard, so placed that it confronts the eyes of those who come in, bearing these words:—'Please wipe your feet.' The building is very badly kept, disordered, and full of dust. Not long ago a visitor, after noticing this general untidiness of the interior, took down the notice as he came out, and changed it to a position where it only confronted the eyes of those who were making their exit from the building!

351.

SHREWD.—An English manufacturer, who was noted for his natural shrewdness, as well as for the goodwill he bore his men, one day wanted some work done by a certain skilled workman. Unfortunately, the man was given to drink, and a bargain was struck that, besides his wages, he should have unlimited gin and water. 'Now, mind,' said the master, 'you promise to drink up what I first give you before you touch a drop more.' As the work went on, the man asked for his gin. 'How much will you start with?' 'Sixpen'orth.' 'Now, gin and *water*, mind; and you must drink it all before you drink again. Which will you have, hot or cold?' 'Cold.' 'All right. Bring me a pail of water.' It was brought, and into it the gin was poured. The man was taken aback, but he was held to his bargain, and finished the work. He went away sober, with his wages in his pocket.

352.

AWKWARD.—At a small dinner-party one evening last week, a boy, evidently from the confectioner's shop, had been engaged to do the waiting. When he placed two dishes of pastry before the hostess, she, probably thinking it not correct to know what was coming, asked—'What are these, William?' Whereupon the boy, pointing to one dish of tarts and then to the other, replied—'Them's a penny each, and them's two for three-'a'pence.'

353.

TO SATISFY HER QUALMS.—Amy Bell, a little girl seven years old, not long ago entered a big savings' bank, and timidly said that she would very much like to be shown over the building as soon as convenient. As Amy is a very attractive little maid, her request was complied with. It was a dull time of the day, and one of the clerks escorted her all over the place, exhibited the workings of the big locks, and laughingly introduced all the gentlemen to her. When going out, Miss Amy thanked them, and said—'You see, my papa has put five shillings here for me, and I wanted to be sure it was in a safe place. Thank you.' And out she marched, radiant and satisfied.

354.

IT SERVED HIM RIGHT.—A gentleman travelling, once stopped to have something repaired in his cart, and during the work the blacksmith threw a red-hot bolt on the ground to cool. A Kaffir dexterously seized it between his toes in passing, intending to make off with it. It may be imagined how he screamed with pain when he discovered his mistake. The iron had become wedged so tightly between his toes that he could not release it with the aid of his fingers, and awful was the plight in which the thief rushed bellowing into a neighbouring pool of water.

NEW DICTATION TESTS.—STANDARD IV.

Suitable for 'Unseen Tests' in Reading also.

No. 214.

CHINESE boys have a great many amusements open to them. They play marbles as we do, only the marble is rolled with the foot instead of the fingers. They play a game like battledore and shuttlecock, only the sole of the foot takes the place of the battledore. It is wonderful what skill they acquire in the game, and the length of time they will keep the little tuft of feathers in the air, never allowing it once to touch the ground.

No. 215.

AT almost every station on a German railway the station-master has a parrot so trained that, whenever a train draws up at the platform, it commences calling out the name of the station distinctly; and it continues doing so while the train remains there. This has been found an excellent way of informing the passengers where they are.

No. 216.

KITE-FLYING is universal in China, though it is more of a man's amusement. But the range of toys for children is almost endless in its variety, and while they are ruder and far cheaper than the elaborate clock-work contrivances with us, they serve their purpose equally well. Boy life in China, however, is not all made up of play. His preparation for manhood is made much the same as with us, and when he reaches a suitable age he is either sent to school or put to work.

No. 217.

A PECULIARITY about the blind is that there is seldom one of them who smokes. Soldiers and sailors accustomed to smoking, and who have lost their sight in action, continue to smoke for a short while, but soon give up the habit. They say it gives them no pleasure when they cannot see the smoke, and some have said that they cannot taste the smoke unless they see it.

No. 218.

THE wren always adapts her nest to the colour and appearance of the surrounding foliage. For instance, in a beech hedge in which the leaves of the last year still remain at the time when the birds begin to build, the wrens form the outside of their nests entirely of the withered leaves of the beech, so that, large as it is, the passers-by would never take it for anything more than a chance collection of leaves heaped together.

No. 219.

THE two sides of the human face are not exactly alike, and a learned biologist asserts that the lack of symmetry, as a rule, is confined to the upper part of the face. In two cases out of five the eyes are out of line, and seven persons out of every ten have one eye stronger than the other. Another singular fact is that the right ear is almost invariably higher than the left.

No. 220.

IN Siam, when there is a question at law between two parties and a scarcity of witnesses to establish the truth in the case, it is customary to resort to the water test. Both parties are required to dive simultaneously into deep water, and the one that stays the longer under is adjudged the truth teller and gets the verdict.

No. 221.

THERE were two ways of preparing grasshoppers to be eaten. They were either crushed in wine and eaten without cooking, or else—and this is the way they are still prepared for food in Syria and Arabia—they were boiled in salted water, their wings plucked off, and then the insects dried in the sun, when they were ready to be eaten.—(H. M. I.'s Test.)

No. 222.

THE man thoroughly in earnest does his work well, never misses an opportunity, always calculates the cost of every step he takes, and warily looks before him and around him to avoid those traps which the world sets so plentifully in his path. Talent goes a great way; opportunity does a great deal; but if you wish to succeed—Be in earnest!

No. 223.

THE North London Railway Company has instituted a new method of supplying workmen's tickets. Owing to the great number of persons having to be supplied with tickets every morning, the Company has placed at some of their stations an automatic machine, and by placing two pennies in the slot an ordinary workman's return ticket is delivered.

No. 224.

A LINEN collar has been put to a strange use by a resident of Gloucester. Upon clearing the letter-box at the post-office there recently, it was discovered that a letter had been written upon one side of this useful article of apparel. It being properly stamped, the missive reached its destination.

No. 225.

A BULL-FIGHTER in South America recently created a sensation by entering the ring on a bicycle. For some little time he eluded the attacks of the bull, but finally the savage animal managed to catch his horns between the spokes of the machine, and sent it flying over the barrier, somewhat the worse for wear. The rider escaped without serious injury.

No. 226.

SEALS are very foolish beasts. The present generation have never seen man, and they survey him open-mouthed and fearful, during which process they are laid low with club or bullet. Sometimes they are so lazy with sleep that a man may dig them in the ribs with the muzzle of his gun, and, wondering what is disturbing their slumbers, they raise their head, which quickly falls, pierced with a bullet. Seldom do any escape—one cartridge means one seal.

No. 227.

IN Labrador, before milking the reindeer, the milkmaid places a string in the pail. By the time the milking is finished the lacteal fluid is frozen solid. The girl thereupon takes hold of the string, lifts the frozen mass of milk from her pail, throws it over her shoulder, and marches with it thus to her hut.

No. 228.

A SERVANT was directed by his mistress, a lady of large size, to book two seats for her in a stage coach, as she wished to be comfortable regardless of expense. The footman returned with the information that he had secured the two seats, but upon being closely questioned admitted that one was on the inside and the other on the outside.

No. 229.

FOREIGNERS travelling in India cannot fail to be impressed with the crowds of natives to be found at every railway station. As a rule, the people have no idea of time, but they have learned that trains do not wait for tardy passengers, so they begin to gather hours before the time for the train to leave.

No. 230.

IN the Sandwich Islands the apple has become wild, and forests of trees of many acres are found in various parts of the country. They extend from the level of the sea far up into the mountain sides. It is said that miles of these apple forests can occasionally be seen.

No. 231.

DOGS instinctively rise to their hind legs when they want to seize anything; the tricks which they are taught depend mainly on their keeping in that position for the greater part of the time. Elephants, however, are by far the easiest animals to train. Indeed, a well-known lady performer possessed one which she boasted never needed being shown twice how to do a trick.

No. 232.

THE roar of a lion can be heard farther than the sound of any living creature. Next comes the hyæna, then the screech owl, the panther, and the jackal in succession. The donkey can be heard fifty times farther off than the horse, and the cat ten times farther than the dog. It is strange that the quiet and timid hare, when she cries in fear, can be heard farther off than either dog or cat.

No. 233.

IN some of the German towns, when a man is convicted of beating his wife, he is allowed to go to his work as usual, but his wife gets his wages, and he is locked up only on Saturday nights, and remains in prison until the following Monday. The punishment usually lasts for ten weeks.

No. 234.

THERE lived once a Bishop of Winchester named Swithin. When he came to die, he asked to be buried on the north side of the Cathedral, where the rain of heaven could fall freely. About a hundred years afterwards, on the 15th of July, his body was to be taken up out of the grave and put in a rich shrine. Heavy rain fell on that day, and continued for the thirty-nine following days, which prevented the removal of his body. This gave rise to the superstition respecting a wet St. Swithin's day.

STANDARDS V.—VII., AND 1ST & 2ND YEAR P.T's.

No. 197.

SEVERAL of the Australian colonies, where the railways, telegraphs, and other public services are under Government control, have adopted a policy of sending officials to other countries to study the conduct there of affairs in their special line, and generally to gather experience. Railway managers, telegraph engineers, city officials, and many such persons holding executive positions, have lately been sent to Europe and this country to study up their speciality.

No. 198.

THE Bank of France is guarded by soldiers, who do sentry duty outside the bank, a close watch being likewise kept within its precincts. A former practice of protecting this bank was to get masons to wall up the doors of the vaults in the cellar with hydraulic mortar as soon as the money was deposited each day in these receptacles. The water was then turned on, and kept running until the cellar was flooded. A burglar would thus be obliged to work in a diving-suit and break down a cement wall before he could even begin to plunder the vaults. When the bank officers arrived each morning the water was drawn off, the masonry torn down, and the vaults opened.

No. 199.

WE heard recently of a man who has a natural barometer, in the shape of a big green frog, captured three years ago. He has a globe of fresh water for the frog to dive in, while an empty glass fruit-jar, inverted over the mouth of the globe, serves as the frog's parlour. From three to eight hours before a rain, the frog will jump out of the water into the fruit-jar and remain there until the rain comes. The gentleman says it is a never-failing barometer, and sets great store by it.

No. 200.

A CURIOUS box was recently found amid the ruins of Pompeii. The box was marble or alabaster, about two inches square and closely sealed. When opened it was found to be full of a pomatum of grease, hard, but very fragrant. The smell somewhat resembled that of roses, but was much more fragrant. What the perfume was made of cannot be conjectured now; but it is singular that men in the nineteenth century should be able to regale their noses with perfumes prepared in the first.

No. 201.

THE Government of Hawaii requires every child to go to school until it is fifteen years old; and none go after they attain that age. Attached to each school there is a policeman, who comes around every morning, obtains a list of absent scholars, and then sets out to find and bring them to school. The children are taught a little reading, writing, and mathematics. They become good penmen, because they are very deft with their fingers; but they never become good mathematicians, because they will not make use of their reasoning powers or do any hard work.

No. 202.

THERE is a band of thieves in Naples who frequent the underground sewers, and bore their way into shops for the purpose of robbery. One morning recently a leather dealer, on unlocking his warehouse, found a large hole in the floor and skins and money gone to the value of three thousand francs. He called the police, and several of them, together with some sewermen, penetrated into the dark vaults with a lantern. They had not gone far when they discovered a man, and called to him to stop. But with a cry of 'Madonna! Do not kill me!' the man fled along the sewer, the police after him. They followed him for at least a mile, passing under three or four streets, but without success.

No. 203.

OUR village is prettily placed, for these people have a delicate sense of picturesque beauty. The quaint houses are built of carved wood, and each designer seems to have humoured his own fancy, for there is no end to the variety. Every cottage has its garden, with funny little temples, and tiny bridges over artificial streamlets. The people stare at strangers, but they are never rude, and if you ask for anything that can be bought, you are served with as much prompt courtesy as though you were in Bond Street, London. (H.M.I.'s Test.)

No. 204.

SCHOOLS are found in all the cities and villages in China, supported by tuition fees, and all Chinese parents who can possibly afford it send their sons to school. The sons of the poorest peasants —poor with a poverty of which nothing is known in this country— may aspire to the highest offices in the state, excepting only the Imperial throne. This is not a mere theory. All the offices in the gift of the Emperor are filled with the sons of common people. The pathway to these successes is education. Hence every nerve is strained, every sacrifice is made to keep the boy at school.

No. 205.

THE twenty-fifth anniversary of the establishment of submarine telegraphy with the far East was celebrated the other night at the Imperial Institute by a banquet, which the Prince of Wales and other distinguished persons honoured with their presence. Day and night cables are flashing the news of one half the earth to the other half. Indeed, were it possible to realise the comparative emptiness of the morning paper, with its columns bereft of any messages from India, Australia, and the East generally, until 'the mail came in,' the services which submarine telegraphy renders to civilisation might be more fully appreciated.—(H.M.I.'s Test.)

No. 206.

THE departure of a train from a Spanish station is generally a very leisurely proceeding. The first bell is taken to mean that the porters must leave off borrowing cigars from the passengers, the second is a hint to the engine-driver to finish his lunch, and at the third the guards begin to slam doors as a warning to stragglers to get inside. Ten minutes afterwards the head guard sounds his whistle, and five minutes later the engine responds with a shriek, which signifies that the excuses for delay are exhausted. Then the train moves slowly forward.

No. 207.

THE little sons of the Emperor of Germany have a hard time of it. Every morning they are called out of their beds at seven o'clock; cold baths are then the order of the day; and after that studies and military exercises take up most of their time. It was said a little while ago that the health of the Crown Prince was failing under the rigorous discipline which his father considered necessary to prepare him for the position of German Kaiser. Every week an old soldier comes to the palace, and gives his young pupils, by the aid of tin soldiers, a lesson in military tactics.

No. 208.

SOME fishermen were out rowing in their boat off the coast of Cornwall, when they encountered a large fish playing and leaping about them with such force as to place their boat in jeopardy. They succeeded, however, in arresting the gambols of the offender by passing a noose over its head, and on hauling it up they found it to be an immense black shark. But the most remarkable discovery was that he had a wooden hoop round his body, which must have been the result of some youthful frolic, for he had since become so portly that the hoop was almost imbedded in his flesh.

No. 209.

THE Hindoos possess a very curious ability to use their toes in various industrial occupations. In the native quarters of the towns of India, the strange spectacle may be seen of a butcher seizing a piece of meat in his hands and cutting it in two with a stroke of his knife held between the first and second toes of his foot. The shoemaker uses no last, but turns the unfinished shoe with his feet while his hands are busy in shaping it. So the carpenter holds with his great toe the board he is cutting, and the wood-turner handles his tools as well with his toes as with his fingers. This use of the feet to assist the hands in their labour is not, however, the mere result of practice, but is principally due to the fact that the Hindoo foot is quite different from ours in its anatomical conformation.

No. 210.

MUCH of the underrated danger endured by whalers is to be removed by the advent of a new sort of harpoon. When the weapon enters a whale it administers a dose of seven hundred and twenty electric shocks a minute, rendering the animal insensible and an easy prey to its captors. This is a decided improvement on the other way of getting towed along half under the water at a rate of fifteen knots an hour, with the prospect of colliding with an ice-floe or being smashed to atoms by a whack from the monster's tail.

No. 211.

CHINESE junks and boats have eyes carved or painted on the bows, which are usually supposed to be a mere fanciful form of ornamentation. But they have a real meaning, as a recent traveller found. In going up a certain river he was startled one day by seeing a boatman seize his broad hat and put it over one of the 'eyes' of the boat, while other boats on the stream were similarly blinded. Looking about for an explanation, he saw a dead body floating past, and he was told by the boatman that if the boat had been allowed to 'see' it some disaster would surely have happened either to passengers or crew before the voyage was ended.

No. 212.

THE palm tree is very useful; it grows erect, sometimes to the height of eighty feet. One variety bears a delicious fruit—the date; another the cocoanut. Its leaves supply us with fans, hats, and slippers. Its wood is valuable, and furnishes tools for the workman, and chairs and beds for the weary. It gives us furniture, lamps and oil, books and paper, bows and arrows, lines and nets, sails and cordage, food and medicine. It makes the palanquin in which the Eastern traveller is carried; his goods are packed in bags and baskets of palm; he sleeps on a mattress of palm, and his room is roofed, curtained, and carpeted with it.

No. 213.

EVERY visitor to Japan is impressed with the many curious uses to which fans are put. The umpire at wrestling and fencing matches uses a large fan, shaped like a butterfly, and the various motions of this fan constitute a language which the combatants fully understand and promptly heed. Men and children, as well as women, use fans at all times. The servant girl has a flat fan, made of rough paper, to blow the charcoal fires with or use as a dust-pan; the farmer has a stout fan to winnow his grain; and another variety is made of waterproof paper, which can be dipped in water, and creates great coolness by evaporation without wetting the clothes.

No. 214.

To secure rattlesnakes the hunter grasps a silk handkerchief at one corner, and allowing the other end to hang towards the serpent, teases her until she strikes it with her fangs, when he immediately raises the handkerchief from the ground, thus depriving the snake of any opportunity of disengaging herself therefrom, as the slightly curved fangs are hooked in the material. The hunter then kills the serpent by first grasping her neck with his disengaged hand, so as to prevent her biting him when he cuts off her head. Should he desire, however, to keep the snake for curiosity or for sale, he extracts the fangs with a small pair of forceps.

No. 215.

WHAT is most striking in this marvellous country is the apparent happiness of everybody. There is no poverty, and neither man nor beast seems to be ill-treated. The Japanese are gentle, remarkably courteous, and very honest. A gentleman came out as a professor to one of the universities not long ago, and he said, 'When I see how good and cheerful and polite these heathen are, I almost want to be a heathen myself.' The tradesmen are hard bargainers, but when once the bargain is made the buyer may reckon with certainty on receiving honest goods, and he may be sure that elaborate care will be taken to send his purchases safely home.—(H.M.I.'s Test.)

No. 216.

ONE of the industries in connection with the tea trade is the collection of the lead with which the tea-chests are lined. China has been noted for many centuries for the purity of its lead, and this tea-chest lead, as it is called, is regarded as the finest in existence. No machinery is employed in the production of this sheet-lead: every sheet is made by hand, and in the most primitive fashion. A large brick is provided, the size of the sheet of lead to be made, and is covered with two or three sheets of paper. On these the molten lead is poured, and another brick is placed on top, which flattens the lead out to the required size and thickness. The sheets are then soldered together to the size of the interior of the tea-chest; the tea is packed in, and the top sheet is fastened in position.

CIRCULAR TO SCHOOL BOARDS.

SCHOOL BOARD ELECTION EXPENSES.

Education Department,
Whitehall, London, S.W.,
7th June 1895.

SIR,

I am directed to enclose, for the information of your Board, a copy of an Order which has been made by the Lords of the Committee of Council on Education regulating the expenses and remuneration of Returning Officers at the election of School Boards.

In laying down the revised scale of charges for these elections, my Lords have taken into consideration the scales which have been prescribed by the various County Councils and by the Local Government Board for elections under the Local Government Act, 1894. In view of the increased frequency of elections of various local bodies in the last few years, my Lords consider that it is important that the expenses should be reduced to the lowest scale which is compatible with continued efficient conduct. When the scale of expenses for School Board elections which has hitherto been in force was introduced, the novelty of such elections and the difficulty of obtaining persons qualified by position and training to discharge the duty of Returning Officer to the satisfaction of the Education Department and of the electors, led their Lordships to allow a somewhat high scale of charges. There are now many persons in every neighbourhood well qualified to conduct an election, and in the opinion of my Lords the time has arrived when the scale of charges allowed to Returning Officers at School Board elections should be assimilated to those allowed to other persons who discharge the same duties at other elections.

Under the new Orders, which will shortly be issued, the Mayor will still be nominated as the Returning Officer for a School Board in a borough, and the Clerk to the Guardians for a School Board for a parish or parishes not included in a borough, but provision will be made that the Mayor may appoint a deputy, and that if the Clerk to the Guardians does not desire to act, the School Board may appoint some person to act as Returning Officer in his place.

One further important change is made by the enclosed regulations. Hitherto, in cases of dispute between the Returning Officer and the School Board as to the expenses of the election, the bill has been taxed by the Education Department. In future, the duty of taxation will be undertaken by the Registrars of County Courts.

The changes indicated above will come into operation in September next.

I have the honour to be, Sir,
Your obedient Servant,
G. W. KEKEWICH.

To————————
Clerk to the School Board.

ORDER REGULATING THE REMUNERATION AND EXPENSES OF RETURNING OFFICERS IN SCHOOL BOARD ELECTIONS.

At the Council Chamber, Whitehall, the 31st day of May, 1895. By the Lords of the Committee of the Privy Council on Education.

Their Lordships read and approved the following General Regulations as to the remuneration and expenses of Returning Officers and other officers requisite for the purpose of the election of a School Board:—

1. The following charges may be made by the Returning Officer, but the charges are in no case to exceed the sums actually and necessarily paid or payable:—

I. *Remuneration.*
Maximum fee for conducting the election, such fee to include all expenses for professional and other assistance, and all other charges except for sums actually disbursed:

	Uncontested Election.	Contested Election.
	£ s. d.	£ s. d.
i. Where the population of the school district—		
(*a*) does not exceed 500	0 10 0	2 0 0
(*b*) is 500 or upwards, but does not exceed 1,000	1 0 0	3 0 0
(*c*) is 1,000 or upwards, but does not exceed 5,000	1 10 0	4 0 0
(*d*) is 5,000 or upwards, but does not exceed 20,000	2 10 0	
(*e*) is 20,000 or upwards	3 0 0	
ii. Additional fee where the school district is a 'united school district' within the meaning of the Elementary Education Act	0 10 0	1 0 0
iii. Additional fee for each polling station after the first	—	2 0 0
Provided that the total fee shall not in any case exceed		50 0 0
Except with the express previous consent of the Education Department the number of polling stations must not exceed in a borough one for each ward, and in a parish one for every 1,000 persons entitled to vote at the election.		

	Contested Election.
II. *Maximum Disbursements.*	£ s. d.
For the presiding officer at each polling station; when the poll is open from 12 (noon) to 8 p.m. - - - - - - - - - -	1 10 0
When the poll is open from 8 a.m. to 8 p.m. -	2 0 0
For one clerk at each polling station where not more than 500 voters are assigned to such station:—	
When the poll is open from 12 (noon) to 8 p.m. - - - - - - - -	0 12 6
When the poll is open from 8 a.m. to 8 p.m. - - - - - - - - -	0 15 0
An additional clerk at the above rates may be employed at a polling station for every 500 voters or fraction thereof beyond the first 500 assigned to such polling station.	
Where the number of electors entitled to vote exceeds 500 and the counting of the votes cannot be completed before 9 p.m., for every person employed in counting the votes, not exceeding two persons for the first 500 electors entitled to vote, one additional person for each additional 500 electors beyond the first 500, and one additional person for each additional 1,000 electors beyond the first 5,000 -	2s. per hour with a minimum of 5s.
For copies of the register - - - - - -	The actual and necessary cost, not exceeding ½d. per name copied.
Unless the permission of the Education Department has been previously and specially obtained, no expenses for copying the registers will be allowed in any case in which there has been no poll.	
For stationery, printing, hire and fitting of rooms, conveyance of apparatus, and all other necessary expenditure - - - - -	The amount actually paid, if reasonable.
For Returning Officer's travelling expenses, where necessary - - - - - - -	By rail, 3rd class; by road, where necessary, actual cost not exceeding 9d. a mile each way.

2. No money for refreshment shall be paid to the Returning Officer or Presiding Officer or to any of the persons employed in the election.

3. Where ballot-boxes, fittings for polling stations, and compartments are available for use at a school board election without charge under any statutory provision or otherwise, it shall be the duty of the Returning Officer so far as is practicable to make use of such ballot-boxes, fittings, and compartments, and the Court upon taxation of his accounts shall have regard to this provision.

4. The fee of the Returning Officer, and all other expenses of and incidental to the election of a School Board shall be paid by the School Board out of the School Fund.

5. Should any question arise as to the reasonableness of the Returning Officer's charges, the matter shall be referred for decision to the Registrar of the County Court of the Circuit within which the School District is situate, and his decision shall be final.

If the Registrar be himself the Returning Officer, he shall appoint the Registrar of some other County Court to decide, as to the reasonableness of the charges, in his stead.

6. The fee for taxation shall be such as the Lords of Her Majesty's Treasury shall by order direct, and such fee shall be deposited by the School Board with the Registrar, on referring the Returning Officer's charges for taxation.

7. If the Registrar decide to reduce the Returning Officer's bill by an amount exceeding the amount of the fee so deposited, such fee shall further be deducted from the Returning Officer's bill before payment by the School Board.

8. In the case of the Metropolis, these regulations shall apply to the Deputy Returning Officers, but not to the Returning Officer. The fee of the Returning Officer shall not exceed £105.

9. This order shall apply to the elections of all School Boards which may be held on or after the 1st September 1895.

G. W. KEKEWICH,
Secretary.

'SHOULD BAD BOYS BE BIRCHED—AND IF SO, WHEN?'

HUMOROUS DEBATE FOR BOYS.

BY JOSEPH DESPICHT.

Author of 'Should Men Wear Hats?' 'In 1999,' etc.

Time in performance—30 minutes.

Every father of a son, every son of a father, every schoolmaster of a scholar, every scholar of a schoolmaster, every prince, every peasant, every patrician, every plebeian, every statesman, judge, magistrate, and policeman, must, at one time or another, have been brought face to face with the problem, 'Should bad boys be birched?'

If, in the following pages, I have, once and for ever, settled the question, no one will be more surprised than—THE AUTHOR.

DIRECTIONS.

1. Place the Speaker's chair and desk in an elevated position at BACK CENTRE. In front of these, but on a lower level, place a table and two chairs for the 'Clerks of the House.'
2. The 'Government Bench' should be on R. of chair, at an angle sufficient to admit of the faces of the occupants being seen by the audience. The 'Opposition Bench' should be similarly placed on L.
3. The Clerks' table should be furnished with quill pens, ink, paper, and a few large volumes. If the platform is not a good size, the Clerks' table, etc., may be altogether dispensed with, as the Clerks take no part in the debate further than scribbling notes, or falling asleep.
4. The 'Members' should enter somewhat promiscuously, some keeping their hats on, some reading newspapers; in short, a 'House of Commons' air should seem to pervade the whole proceedings.
5. When a 'Member' rises to address the House, let the Speaker name him distinctly to the audience, as 'Mr. So-and-So,' 'The Right Hon. This,' or 'Lord That.' The fun is greatly enhanced by the members adopting names of well-known statesmen, writers of the day, or local magnates.
6. No particular costumes are *essential*, except the wig and gown of Mr. Speaker and the Clerks of the House, but, for variety, one Member should wear an eye-glass, one a pair of spectacles, and so on, *ad lib.*
7. After a few moments' talk on the part of the assembled Members, the Speaker, preceded by an attendant bearing the Mace, and followed by the Clerks of the House, enters. All rise and bow. Cries of 'Silence for the Speaker,' 'Order,' and 'Chair' are raised. Mr. Speaker, when seated in the Chair, should shake hands with the nearest members, and nod familiarly to some others.

MR. SPEAKER. (Loud cheers as he rises.)

My Lords and Gentlemen, it is by the unanimous vote of both sides of the House that I am called upon, at this critical moment of our history, to carry out the duties of this most exalted chair. (Cheers.) Having to succeed a long line of accomplished orators and observant thinkers, I may well claim your indulgence for any lack of those qualities perceptible in me. (Cheers.) But this I will say, that I yield the palm to no man for the possession of a more earnest desire to carry out those duties with the utmost fairness and impartiality. (Loud cheers.) On this, the first night of my Speakership, may I be permitted, for the sake of all concerned,

to remind you of the hitherto unwritten Rules of Debate which maintain in this House! (Hear, hear!)

First, that our discussions be conducted with dignity, decorum, and despatch—especially despatch. (Hear!)

Secondly, that Members stop all noise directly the Speaker rings his bell, or as soon after as possible. (Hear!)

Thirdly, that not more than one or two Members speak at a time. (Hear, hear!)

Fourthly, that no Member speak more than once on any motion or amendment, unless he feel inclined to do so. (Hear, hear!)

Lastly, that no Member speak for more than, say, forty minutes at a time. (Hear, hear!)

Now, the first business on the paper is a resolution to be proposed by the Government on the important question, 'Should Bad Boys be Birched—and When?' I beg of you to give each side a patient hearing, keep your temper, and, above all, don't come to blows! (Hear, hear!) I call upon the Prime Minister to move his resolution! (Loud cheers as he resumes his seat. These are repeated on Government side as the Prime Minister rises.)

1st Speaker, R.*

Mr. Speaker, the resolution I have the honour of submitting to the Chair is the following:—'That in the opinion of this House, bad boys *should* be birched whenever they deserve it!' (Hear, hear! No, no! and groans.) I was prepared for a certain amount of dissent to that proposition, but, really, gentlemen, I was not prepared to find this historic house turned into a bear garden! (Hear, hear! from Government.) Let me remind some of the *gentle*-men opposite that yells and groans are not arguments; and, that if they think to intimidate me by noise and bluster, they will find themselves grievously disappointed! (Oh, oh! from Opposition. Bravo! from Government.)

Now, when we say that bad boys should be birched, we, of course, include under the generic name of birching, all species of corporal punishment inflicted in our schools, such as, for example, beating with a bundle of twigs—caning—(Hear, hear!)—flogging—(Hear, hear!)—spanking—(Hear, hear!)—smacking—(Hear, hear!)—thrashing—(Hear, hear!)—dressing—(Hear, hear!)—licking—(Hear, hear!)—basting—(Hear, hear!)—whipping and whopping—(Hear, hear!)—switching, swiping, and tanning! (Hear, hear! and laughter.)

In our proposition we confine ourselves, you will observe, to bad *boys;* for such an anomaly as a bad *girl* has, we suppose, never yet been seen! (Loud cheers.) And why do we say bad boys should be birched? (Fourth Speaker, who continually interrupts, cries 'Yes, why?')

I will endeavour to answer the noble lord, who is nothing unless interrupting! We say so because we believe it to be an universal law of nature that everything bad is better for a beating! (Hear!) Take, for instance, a tough beef steak! What does your cook do to make it tender? Why, beat it! (Hear, hear!) What does your wife do to make heavy paste for pastry light? Why, bang it with a rolling-pin! (Hear, hear! from Government.) What does your coachman do if the horses be lazy? Why, whip them, to be sure! Would your corn be fit for food if it were not well *thrashed?* (No, no! on Right.) Would your skins make good leather if they were not well *tanned!* (Hear, hear!) Would your roast turkey be succulent if not well *basted?* (No, no! on Right.) What do you do with your carpets to improve their tone? Why, belabour them with rods! What does the Turk to improve the morals of his prisoners? Why, smack them with the *bastinado!* (Hear, hear!) What does the Arab to improve the pace of his camel? Why, give him a taste of the *courbash!* (Hear, hear!)

Therefore, we say, it seems to be a law of nature that bad things are better for a beating, and we see no reason why bad boys should be an exception to the rule! (Loud cheers from Government—Shame! from Opposition.)

2nd Speaker, R.

Sir, I rise for the purpose of seconding the proposition of our great and distinguished leader! (Cheers on Right.) Useless would it be for me to attempt to imitate his unrivalled eloquence; unnecessary is it for me to add to his multifarious examples; for it seems to me that, after his exposition, there can be no two opinions about the matter—(Hear, hear! and Oh, oh!)—and I venture to hope that we shall not leave this House to-night without coming to a division. (Hear, hear! on both sides.)

The whole thing lies in a nutshell! When we were bad boys, gentlemen, we had to submit to a 'whopping,' and why should the young scamps of the present day escape? (Hear, hear!) I therefore cordially agree with the mover, 'That bad boys certainly ought to be birched whenever they deserve it!' (Hear, hear! No, no! Chair!)

* 'R.' and 'L.' signify 'Right' and 'Left' of 'Chair.'

3rd Speaker, L.

Mr. Speaker, notwithstanding the extraordinary assurance of the opposite party, I rise to show them that there is something to be said on the other side, and that we do not *all* agree with their inhuman proposition! (Hear, hear! from Opposition.) Now, I, for one, unhesitatingly say that I do *not* believe in birching bad boys whenever they deserve it—indeed, I go further, and say, I do not believe in birching bad boys at all! (Loud Opposition cheers.)

And in answering the right hon. gentleman's arguments, I shall place them in two divisions—the serious ones and the frivolous ones. (Hear, hear! and Oh, oh!)

Now the frivolous arguments about beef-steaks, turkeys, and pie-crust, I consider beneath my notice, and I must respectfully decline to waste your time, Sir, and mine, by any further reference to them! (Hear, hear!) And as to the serious arguments, I contend they pointed in exactly the opposite direction to the terms of the proposition. (Hear, hear!) We were told, because the Turk does this, and the Arab does that, we Englishmen ought to do the same! That is to say, the effete degeneracy of moribund Orientalism is to be the pattern of our Western advancing civilization! (Cheers on Left.) One day we are told that the lazy Turk should be driven bag and baggage out of Europe, and the next that we are, in matters of the highest importance, to follow his example! I, myself, should have been inclined to argue that, *because* a Turk uses the bastinado, and the Arab a courbash, therefore we should avoid such things or any instruments of torture like them! (Oh, oh! from Opposition.) Then, as to the universality of the mover's theory, do we really beat everything bad to make it better? Let us go from small to great! Can you improve a bad egg by beating it? (No, no!) Your grape-vines yield no grapes—your hop-bines bring no hops—will thrashing them do them any good? (No, no!) You have a nightingale that sings not, and a cat that catches no mice—will spanking them do them any good? (No, no!) Do you horsewhip your cook if she spoil the gravy?—(Hear, hear!)—or use the cat-o'-nine-tails to the coachman if he drive into a donkey-cart? (No, no! and laughter.) So much, then, for the universality of the theory! No, gentlemen; believe me, birching and basting, banging and beating, are *not* the best means of bettering bad boys, and I shall decidedly oppose the motion! (All rise to speak—Speaker rings bell violently, and then names one.)

4th Speaker, L.

Mr. Speaker, as usual our leader on this side has not been half severe enough with the right hon. gentleman opposite! I therefore rise to complete the annihilation of his arguments, and the discomfiture of his party! (Hear, hear! and Oh, oh!) I think we on these benches are very fortunate in having a man like me, who can give a final knock-down blow to such trumpery trash as we have heard from the other side! (Uproar ensues—bell—Order!)

1st Speaker (rising).

Mr. Speaker, I rise to a point of order. It is outrageous that the words 'trumpery trash' or 'trashy trumpery'—I forget which—should be applied to arguments used by one of my years and experience! (Hear, hear! from Government.)

Mr. Speaker.

The noble lord must certainly recall those words!

4th Speaker.

I humbly bow to your decision, Sir, and recall them! Now, what, it seems to me, the opener chiefly depended on was, that because we beat a donkey, a dog, or a cat, therefore we ought to beat a boy! (Hear, hear! No, no!) Some honourable members opposite cry 'Hear, hear.' Let me push the argument to its legitimate conclusion. We give a horse chaff to eat: therefore, we should give a boy chaff! (Laughter on Left.) We dangle carrots before a donkey's nose to make him go the faster: therefore, we ought to dangle carrots before a *boy's* nose to make *him* go the faster! (Laughter.) And so on to the bitter end! The thing is really absurd, and I am astonished beyond measure that the Leader of the House, with his boasted fifty years of Parliamentary experience, has stooped to make use of such empty, illogical, irrational, inconsequential, idiotic arguments! (Order! Hear, hear! Oh, oh!—bell.)

5th Speaker, R.

Mr. Speaker, my lords, and gentlemen,—The noble lord who has fallen into his seat—(Hear, hear!)—appears to me to be one of those rhetoricians who, when they find they have 'no case,' try what abuse will do! (Hear, hear! on Right.) He seemed to say, 'I am Sir *Adjective*—when I speak, let no dog bark!' (Laughter.) If I might venture to offer advice to the little lord—(Fourth Speaker

jumps up) to the noble lord I mean—I should counsel him to expunge from his illimitable vocabulary all such expressions as 'trumpery trash,' 'idiotic arguments,' etc., etc., and then he will not fail to obtain a more patient hearing than he at present commands! (Hear, hear!) Another thing he might do with advantage, namely, *read* more! For 'Reading maketh a full man,' and empty indeed must be the arguments that need to be stuffed out by abuse! (Hear, hear!)

Now, let us examine what the old writers have to say on this matter. What says glorious old Doctor Johnson, who was himself, for some time, a schoolmaster? Why, that 'Severity must be continued till obstinacy be subdued and negligence cured.' (Loud cheers on Right.) And, further, he remarked one day, 'There is now less flogging in our great schools than formerly—but then, less is learned there; so what the boys gain at one end, they lose at the other!' (Laughter and cheers.) It would weary you to cite the numerous examples of flogging boys amongst our forefathers, but it was done. And if the thing has been necessary in the past, it surely must be so now, and will be in the future. I shall therefore vote with the 'Ayes.' (Cheers and groans—several rise to speak.)

Mr. Speaker.

Mr. M——— (naming 6th Speaker) has caught my eye!

6th Speaker, L.

Mr. Speaker, of all the speeches made up to the present time in support of the motion, the last was, I think, the most unfortunate! (Hear, hear! on Left.) Before the last speaker attempted to offer his fatherly advice to hon. members on this side, he should have looked to see whether, or no, his own house was quite in order! (Hear, hear!) '*Read* more,' exclaimed he! Allow me to return the compliment and advise *him* to read more! (Hear, hear!) We readily admit that Doctor Johnson was in favour of birching; but, permit me to point out that, glorious as Doctor Johnson was in other respects, of all schoolmasters that ever were, he was, perhaps, the worst! (Hear, hear!) How long did he keep his school open? Why, eighteen months! And during that time, his boys got so completely the upper hand of him as to play on him the most extraordinary practical jokes that were ever perpetrated by mischievous boys! (Cheers and laughter.)

Now, *I* will go back as far as Socrates—and I need scarcely remind men of your 'light and leading,' that Socrates was, perhaps, the most successful educator that any age or nation has produced—What, I ask, did he rely on? No cane! No birchrod! No switching-stool! He relied solely on love! (Loud cheers.) Take Roger Ascham, of whom it was said, 'He was the best scholar of any schoolmaster, and the best schoolmaster of any scholar!' He said, 'Young children are sooner allured by love than driven by beating!' (Hear, hear!) Truly we are justified in telling our opponents to *read* more! (Hear!) In conclusion, I would say to all who have bad boys to deal with, don't try smacking! don't try spanking! don't try flogging! but try patience, gentleness, and untiring love! (Loud cheers.)

7th Speaker, R.

Sir, the remarks of the right hon. gentleman who has spoken last, sound like a leaf torn from a little book called 'DON'T.' (Hear, hear! and a laugh.) I imagine that if he could have his own way, some such set of rules as the following would be posted in every Boys' School in the kingdom, for the information of the masters:—

I. If a boy maliciously place a tin-tack, point upwards, on the seat of the boy in front of him, and you feel inclined to punish him for his cruelty—'Don't!'

II. If a boy throw blots into his copy-book to see how the ink will spread, and you feel it right to punish him—'Don't!'

III. If a boy put on the hands of the clock twenty minutes, while your back is turned, and you feel it best to punish him for his impudence—'Don't!'

IV. If a boy will insist on cracking nuts while you are engaged in teaching him, and you feel justified in punishing him for his obstinacy—'Don't!'

Now I ask you, gentlemen, as men of the world, can schools be conducted on such principles as these? (No, no! from Government) What says Shakespeare himself on injudicious coddling' 'By love' (meaning injudicious love) 'the young and tender wit is turned to folly!' (Hear, hear!) No, *severity* is often the truest love! (Hear, hear!) I say, then, love, of the right sort, must, of course, govern the school, but *discretion* must govern love! (Cheers and hear, hear!)

8th Speaker, L.

Sir, with much of what the Home Secretary has said I can cordially agree; but then no effort has been made to prove the desirability of birching bad boys *whenever they deserve it!* (Hear, hear!) Mark the words 'Whenever they deserve it!' (Hear, hear! from Government.) There is to be no loop-hole—no exception—no justice tempered with mercy! They are to be birched whenever they deserve it! I will give the other side *quid* for *quo!* What says Shakespeare on our side? Why, 'Your dull ass will not mend his pace by beating'—(Bravo!)—and, further, 'Use every man after his *desert*, And who shall 'scape whipping!' (Hear, hear!')

In common fairness, if the boys are to be whipped after their deserts, the *men* should be so treated; and I fancy, if the truth were known, *they* deserve the rod as often as the boys do! (Laughter and Hear, hear!)

9th Speaker, R.

Mr. Speaker, I appeal to you, are we not really trying to settle what has long ago settled itself! Rightly, or wrongly, the whole sum of human experience on this matter has concentrated itself into the formula of the sacred writer, Solomon, 'Spare the rod and spoil the child!' (Hear, hear!) The ancients agreed with it; modern writers, in the main, agree with it; and, unless we are prepared to turn the whole system of education upside down, we must agree with it, too! (Hear, hear from Government; No, no! from Opposition. Chair!—bell.)

10th Speaker, L.

Sir, it has been truly said, 'A little knowledge is a dangerous thing!' We are coolly told that Solomon has said, if we spare the rod we spoil the child! Now I beg to inform the Attorney-General that Solomon never used those words at all, and I defy him to produce the reference! (Bravo! bravo!—4th Speaker cries 'Read more!) Then, again, the learned gentleman dared to make himself the spokesman of the whole human race, before he had even taken pains to get at the meaning of the old proverb he quoted! (Oh, oh!)

His paraphrase of it evidently would be, 'If you don't thwack your boy with a stick, he will become a bad man!' (Hear, hear! on Right.) Really, I am almost overcome with such an exhibition of crass ignorance! Would the right hon. gentleman be surprised to hear that 'rod' signifies that which sustains and supports—just as *bread* is called the rod or 'staff of life!' (Hear, hear!) And would he also be surprised to hear that 'to spoil' here signifies 'to rob'—just as we say to spoil or rob the enemy! (Hear, hear!)

The real meaning of the proverb, then, is plain—'The man who spares or stints the necessary support of life, actually robs his child'—and the words have no reference to castigation or correction at all! (Bravo!) I shall oppose the barbarous and repulsive motion to the utmost extent of my power! (Bravo! Order!—Bell.)

11th Speaker (from among the audience—hat on.)

Mr. Speaker, I should not, as a private member, have ventured to take part in this debate, but that it seems to me no one has, as yet, taken up the cudgels on behalf of us the *fathers* of the bad boys! (Hear, hear! and 'Hats off!') I hope, Sir, you will allow me to address the House with my hat on: I am very bald, and the draught from above is very chilly! (Mr. Speaker: 'Oh, certainly.')

Now I was going to urge that we fathers ought to have something to say in this matter! What, I want to know, is to become of us if our boys are to be brought up on this namby-pamby system of petting and pampering? What are we parents to do if our boys are lazy, or saucy, or rude? Are *we* never to chastise them? (Yes, yes! and No, no!)

I appeal to all the best fathers here—Were you brought up like that? (No, no! from Government.) Were you never switched at Eton? (Laughter.) Did you never taste a cane? (A voice: 'Hardly ever!') If you broke the metaphorical jug, or spilt the typical milk, did you never receive the parental smack? (Hear, hear! and Yes, yes!) If, instead of accompanying your aunt to church, you went birds'-nesting and tore your small clothes, what was done to you? I don't think you were petted and kissed! And look what splendid fellows you have turned out! (Hear, hear! and laughter on both sides.) It's bad enough for the mothers to spoil the boys, we don't want the schoolmasters to spoil them, too! (Hear, hear!)

And we must not forget that when we send the boys to school, we place the master in *loco parentis*—in the place of the parent—and that, therefore, what the parents may do at home, the master may, by law, do at school? (Hear, hear!) Gentlemen, I am a real Roman father! I know what boys are! If you don't keep the upper hand of them, they'll very soon get the upper hand of you! And I hope that all schoolmasters will continue to give the young scamps a thorough good thrashing whenever they deserve it! (Cheers from Government.)

1st Speaker.

We want a First Lord of the Admiralty—would the Member for Birchington mind stepping up into the Cabinet?

11TH SPEAKER.

Oh, certainly! (He mounts the platform amid cheers and sits on Government Bench—all rise to speak—one is named.)

12TH SPEAKER, L.

Sir, the venerable and highly estimable old gentleman who has just accepted a despatch-box, is no doubt an admirable father, but I venture to say he would make a still more admirable nigger-driver! (Hear, hear! on left.) I shall say nothing about his want of hair, but I must call your attention to his utter want of sympathy with boyhood, and its little faults and eccentricities. (Oh, oh! and hear!) Let him speak if he will for the fathers, but I am safe in affirming that there is not a mother in this House, or outside it, who would not repudiate his sentiments with horror! (Hear, hear!) And who, pray, has most to do with forming the characters of the boys? Why, the mothers of course! (Hear, hear!) Women know well, that, as an old writer has said,—'The schoolhouse should be in deed, as it is in name, the House of Play and Pleasure,' and not the house of fear and bondage!" (Hear, hear!) I shall vote against the Roman father, and in favour of the English mother! (Loud cheers.)

(The Speaker here names any prominent Irish Member. The speech should be delivered with a slight 'brogue.')

13TH SPEAKER, R.

Sir, the speech of the right hon. gentleman who spoke so eloquently for the ladies, does infinite honour to his heart, but little credit to his head! (Hear, hear! and Oh, oh!) For let me sketch an ordinary 'Bad Boy's Day,' and then ask you, what is to be done in such a case.

To begin with—his mother calls him at seven—he scrambles out of bed at half-past eight—tosses his clothes on, so that he looks like a bundle of rags tied up badly—in his ablutions, if one may call them so, he leaves curious black rings about his eyes and neck—bolts his breakfast standing—arrives at school half-an-hour late, only to find that he has left all his books behind! (Hear, hear.)

He rushes home again just as the baby is going to sleep after its bath—treads on the cat—kicks the dog, and returns to school at the best possible moment to upset the order in any class! (Hear, hear.) His pen is of course broken—his books are dog-eared—and soon he takes a violent fancy to the next boy's top, just visible in the pocket at his side! (Hear, hear.) He gets each and every exercise wrong, and during the reading lesson, he slyly places 'Dick Turpin's Ride to York' in the covers of his 'English History!' (Hear, hear.) When reprimanded, he uses such elegant expressions as 'Boo,'—'Who cares,'—'Shan't,'—and 'Who are you entirely?' (Hear, hear!) And so he continues through the day, utterly regardless of his own welfare or the progress of his school-fellows! (Hear, hear!) Coaxing and palavering may do for such boys in a hundred years' time, but it will not do now, and therefore I shall vote for the birching! (Hear, hear! Bravo!—all rise to speak).—Mr. Speaker says, 'I call on The Rt. Hon. So-and-so to continue the Debate.'

14TH SPEAKER, L.

Mr. Speaker, no one on this side has ventured to assert that bad boys do not exist; but I do say, for one, they are few and far between; and the danger is, that merely dull boys may be mistaken for, and punished as bad boys, under such a ready-to-hand system of chastisement as birching, caning, etc. (Hear, hear!) And, sir, I must say a word for those dear, dull, stupid boys—for some of the slower ones are very dear fellows indeed! (Hear, hear!)

Let me illustrate this by an example, taken from life, and given me by a schoolmaster, under whose eyes it happened. 'There was once a boy in my school,' says this schoolmaster, 'who had no head at all for figures. They were, I sincerely believe, an utter mystery to him; and no master in the school ever succeeded in getting him past the multiplication table! He was of a sweet gentle disposition, and keenly alive to ridicule. So much so, indeed, that his face would flush, and his nerves quiver when younger boys laughed at his absurd mistakes. As a rule no one punished him, because he plainly tried so hard. One day, however, I thought I would try what a slight punishment with a small cane would do; but, when, for the first time in his life, the cane touched him, he turned so white, and then so red, and was, altogether, so overcome with the degradation of the punishment, that I mentally promised I would never touch him in that way again!

'For a few years he passed tolerably well in everything except sums; but these were a continual trouble to him. At last he fell ill—so ill, that he was obliged to keep his bed. I went to see him, and amongst other things I happened to say, "Shall you not be glad to be back at school?" "I think I should," said he, "if it were not for those dreadful sums. I have been trying all day to remember the difference between four eights and four nines! What *are* four eights, sir?" "Thirty-two," I said. "Isn't it strange" the child added, "I have been saying thirty-six all-day! It seems so much easier to say four eights are thirty-six, and four *nines* are *thirty-two*!" His mother told me that he was continually rambling about some sum that he never could get right, always, however, finishing by saying, "It will come right some day, I suppose!"

'Some weeks passed away and I was again sent for; "perhaps," said the messenger, "for the last time." I went, and found him evidently dying. I spoke to him, but his only answer was, "I think it is coming right, sir!" This he muttered every few minutes, while his breath grew feebler and feebler; until, all in a moment, his pale careworn face broke into such a smile, as I had never seen on it before—it was as though the first dawn of a brighter life was breaking in upon him—the old worried look vanished like a shadow from the sunlight—and crying joyfully, "It's right at last!" he fell back and died.'

Such, I say, was the schoolmaster's story, and I contend that we had better let *fifty* bad boys escape than punish *one* such poor little fellow! (Hear, hear! Hear, hear, from Opposition.)

15TH SPEAKER, R.

Sir, we have all listened with great interest to the touching story which has been so ably related to us by the last speaker, and we, on this side, are perfectly willing to recognise the danger he would warn us against. (Hear, hear!) Still, I cannot help thinking that we are wandering somewhat from the real question! (Hear, hear!) In this debate, we have nothing whatever to do with *good* boys—if indeed there are such things—(Oh, oh, and groans from Opposition)—we have only to decide the question,—'Should *bad* boys be birched.' (Hear, hear!) Now, there is a wise old saying which runs:—

'A woman, a dog, and a walnut tree,
The more they're beaten, the better they be!' (Laughter.)

I am, as you know, a man of peace, but I maintain that what is good for the mother goose is good for the gosling ganders; and if all these things are better for a beating, there can be no shadow of doubt that bad boys may be improved by the same process! (Hear, hear! No, no! Several cry 'Mr. Speaker'—one is named—bell.)

16TH SPEAKER, L.

Mr. Speaker, I do not for a moment complain of a lack of argument in the opener's address, but declare that he 'out-Heroded Herod,' and proved the absurdity of his own proposition! For, said the Prime Minister, everything in nature is better for a beating or a banging, a thrashing or a tanning, as the case may be! And he gave as examples, beef-steak, corn, and leather. (Hear, hear! from Government.) But surely no one will deny that that these are *good* things, and not *bad*. (Hear, hear! on Left.) If therefore his premises are true, and his deductions logical, good things, as well as bad things, are better for a beating; and consequently *good* boys as well as *bad*, ought to be birched; which is absurd! (Bravo, bravo! on Left.) And, further, it follows from his argument that *good* boys should be birched whenever they *deserve* it; which is plainly a contradiction in terms! (Loud cheers.)

I really do hope that the opposite side will see the utter fallacy of their arguments, and come to a division at once! (Hear, hear! Divide, divide!—bell, etc.)

17TH SPEAKER, R.

[The name of some well-known 'Temperance' Member should be chosen for this speaker.]

Sir, before we proceed to a division, I must insist on saying a few words on behalf of those bad brats who have been so unmercifully sat upon this evening! (Hear, hear! on Left.) I have the reputation of being a terrible Radical myself, and, therefore, may well feel for the young Turks! (Hear, hear!) But, I assure you, even I am not half so black as I am painted; indeed, my private opinion about myself is that I am quite a milk-and-water-sort of man! (Laughter.)

Now, let me ask, who is it that *makes* these bad boys bad? Why, very often, those who are responsible for their bringing up! (Hear, hear!) If a watchmaker turn out a bad watch, you don't blame the watch, you blame the workman! If your tailor turn out an ill-fitting coat, you don't scold the coat, you growl at the tailor! (Hear, hear!)

Then, there's that terrible brewer! (Hear, hear!) He has a deal to answer for! Keep his beer out of your houses and give the boys water! (Hear, hear! and Oh, oh!) There will then be far less misconduct in schools, and, as a consequence, far less smacking and spanking, switching and flogging; indeed, there would soon be

no bad boys to be birched; but, till the beer and its kindred spirits are banished, I must reluctantly vote for the birch! (Hear, hear! on Right. Oh, oh! on Left. Divide, Divide!)

18TH SPEAKER, L.

Sir, I hope Her Majesty's Government will restrain their impatience for a few minutes, and not proceed too hastily to a division on this important matter! (Hear, hear! Divide!) For, if I am rightly informed, Ministers do not intend to resign if the Vote goes against them. (Hear, hear! on Right. Oh, oh! on Left.) Seeing, then, that this is not to be made a party question, I hope that we shall endeavour, by some means or another, to come to an unanimous decision! (Hear, hear!)

Each side has undoubtedly the welfare of the boys at heart; the only difference of opinion being as to the best means of promoting that welfare. (Hear, hear!) 'Birch them whenever they deserve it!' say the Government. 'Let the poor fellows off,' say the Opposition. Now, true wisdom frequently lies in taking a middle course, and therefore I venture to suggest a compromise on the question! (Hear, hear! and No, no!)

It happens, now, that the sting of the Prime Minister's proposition lies in its tail! (Hear, hear! on Left.) That is to say, in the words, 'Whenever they deserve it!' (Hear, hear!) With regard to the body of the motion, 'That bad boys should be birched,' I think I may promise its acceptance on this side of the House. (Hear, hear! on Left.) Surely, then, if we give way at the head, the Government will give way at the tail; thus we shall all give way without appearing to the country to do so! (Hear, hear! on both sides.)

Now, the following is the alteration in the tail of the proposition, which I shall ask the Right Hon. gentleman to accept, 'That, in the opinion of this House, bad boys *should* be birched'—not, mark you, whenever they *deserve* it, but—'whenever they *desire* it!' (Cheers from both sides.)

This, I take it, gentlemen, is a free country! (Hear, hear!) Your doctor is at liberty to tell you what is good for you, but he may not force his stuff down your throat against your will! (Hear, hear!) While, on the other hand, if asked by a patient to administer a powder or a pill, no cruel law forbids him to do so! (Hear, hear!)

Now apply this to the case of a bad boy. In a free country a schoolmaster should, of course, have the liberty to say, 'My boy, I think a sound thrashing would do you good,' but it would be monstrous to allow him to force the drubbing on the boy against his will! (Hear, hear! Hear, hear!) But conceive a boy, and the case may very well happen; conceive a boy who has done some mischief, coming to his master and saying, 'Sir, I have been a bad boy—I know I have—I think a severe thrashing would do me good: will you kindly administer it?' (Laughter and cheers.)

Now, shall we pass a law forbidding the schoolmaster to do as the bad boy desires? (No, no! No, no!) Certainly not! and I therefore hope, to secure a decision as nearly as possible unanimous, the Leader of the House will agree to change the word 'deserve' to the word 'desire'? (Hear, hear! Agreed, agreed!)

MR. SPEAKER.

Do I understand that the Prime Minister is willing to accept the alteration? (1st Speaker then appears to consult with his colleagues in an undertone.)

1ST SPEAKER.

Yes, I do!

MR. SPEAKER.

You all know the terms of the amended motion; those who agree, cry 'Aye.' (All cry 'Aye.') On the contrary, 'No.' (Silence.) Carried *nemine contradicente!* It is therefore decided, once and for ever, 'That bad boys are to be birched, whenever they *desire* it.' (Loud cheers.)

Curtain.

QUERY COLUMN.

R. Fish, Board School, Levels, near Doncaster.—Whereabouts in a coal-shaft will the corves meet if the radius of the roll be $3\frac{1}{2}$ ft., the thickness of the rope $\frac{1}{8}$ foot, and the depth of the pit 1,020 ft.

It must be remembered that for the ascending corve the radius of the roll increases by $\frac{1}{8}$ foot for each revolution, while for the descending roll it diminishes by the same amount for each revolution. The successive radii of the roll are, therefore, in arithmetical progression, the common difference being $\frac{1}{8}$ foot. According to the formula for summing an arithmetical progression if a = first term, n = number of terms, b = the common difference, and S = the sum of n terms.

$$S = \frac{n}{2}\left\{2a + (n-1)b\right\}.$$

Here to find the number of turns required to raise a corve from the bottom, we must remember that the sum of the terms only gives us the sum of the successive radii. This must be multiplied by $6\frac{2}{7}$, the number of times a radius is contained in the circumference of a circle to find the amount of rope wound on the roll in n revolutions. This will evidently equal 1,020 ft. Remembering that $a = 3\frac{1}{2}$ and $b = \frac{1}{8}$.

$$1{,}020 = \frac{44}{7} \times \frac{n}{2}\left\{7 + (n-1) \times \frac{1}{8}\right\}$$
$$= \frac{44}{7} \times \frac{n}{2} \times \frac{55+n}{8} = \frac{11n(55+n)}{28}.$$

Simplifying,

$$\therefore 11n^2 + 605n = 28{,}560.$$

Divide all terms by 11, $\therefore n^2 + 55n = \frac{28{,}560}{11}$.

Complete the square,

$$n^2 + 55n + \left(\frac{55}{2}\right)^2 = \frac{3{,}025}{4} + \frac{28{,}560}{11}$$
$$= \frac{147{,}515}{44} = 3352{\cdot}5, \text{ etc.}$$

Extract square root,

$$\therefore n + \frac{55}{2} = 57{\cdot}9.$$
$$n = 57{\cdot}9 - 27{\cdot}5 = 30{\cdot}4 \text{ turns.}$$

Now in 30·4 turns the radius of the roll increases by $\frac{1}{8}$ foot $\times$ 30·4 = 3·8 feet.

If we now imagine a corve to be wound to the top of the shaft, and to be ready to descend, the radius of the roll at the beginning is $3\frac{1}{2}$ ft. + 3·8 ft. = $7\frac{3}{10}$ ft. During the descent this decreases for each revolution by $\frac{1}{8}$ foot.

If now two corves, one ascending and the other descending, start at the same time, they will when they meet have accomplished between them 1,020 ft., or the depth of the mine.

Now if x = the number of turns of the roll required before they meet, the distance accomplished by the ascending corve equals

$$\frac{x}{2}\left\{2a + (x-1)b\right\} \times \frac{44}{7},$$

where $a = 3\frac{1}{2}$ ft. and $b = \frac{1}{8}$ ft.

The distance accomplished by the descending corve equals

$$\frac{x}{2}\left\{2A + (x-1)B\right\} \times \frac{44}{7},$$

where $A = 7\frac{3}{10}$ feet and $B = -\frac{1}{8}$ ft.

Then $\left[\frac{x}{2}\left\{2a + (x-1)b\right\} \times \frac{44}{7}\right] + \frac{x}{2}\left[\left\{2A + (x-1)B\right\} \times \frac{44}{7}\right]$ = 1,020 feet.

That is,

$$\left[\frac{x}{2}\left\{7 + (x-1) \times \frac{1}{8}\right\}\right] \times \frac{44}{7} + \left[\frac{x}{2}\left\{14\frac{3}{5} + (x-1) \times -\frac{1}{8}\right\} \times \frac{44}{7}\right] = 1{,}020.$$

Simplifying,

$$\left[\frac{22x}{7} \times \frac{55+x}{8}\right] + \left[\frac{22x}{7} \times \frac{589-5x}{40}\right] = 1{,}020.$$
$$\frac{11x(55+x)}{28} + \frac{11x(589-5x)}{140} = 1{,}020.$$

Multiply all terms by 140,

$$55x(55+x) + 11x(589-5x) = 142{,}800.$$
$$3{,}025x + 55x^2 + 6{,}479x - 55x^2 = 142{,}800.$$
$$\therefore 9{,}504x = 142{,}800.$$
$$\therefore 198x = 2{,}975.$$
$$x = \frac{2{,}975}{198} = 15\frac{5}{198} \text{ turns.}$$

We must now find how far the ascending corve will have risen in $15\frac{5}{198}$ turns of the roll.

Use the formula—

$$S = \frac{n}{2}\left\{2a + (n-1)b\right\},$$

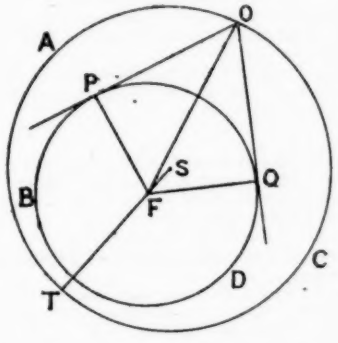
where $n = 15\frac{5}{198}$, $a = 3\frac{1}{2}$ ft., and $b = \frac{1}{8}$ ft.

This must be multiplied by $6\frac{3}{4}$ to give the distance accomplished.

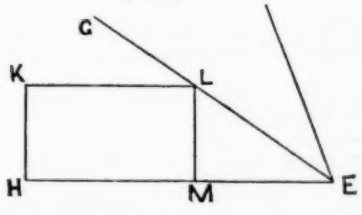
$$\text{Then distance} = \frac{2,975}{396}\left\{7 + \left(\frac{2,975}{198} - 1\right) \times \frac{1}{8}\right\} \times \frac{44}{7}$$
$$= \frac{2,975}{396} \times \left(7 + \frac{2,777}{1,584}\right) \times \frac{44}{7}$$
$$= \frac{2,975}{396} \times \frac{13,865}{1,584} \times \frac{44}{7}$$
$$= 413{\cdot}3 \text{ feet.}$$

This comes to within 7 feet of your answer. The difference is due to the approximations which have been taken in order to avoid lengthy working.

James Stirling (*Glasgow*).—Of two circles, which are not concentric, one lies wholly within the other; find a point in the circumference of the larger circle from which the tangents drawn to the smaller circle shall contain a given angle. Under what circumstances will the construction be impossible?



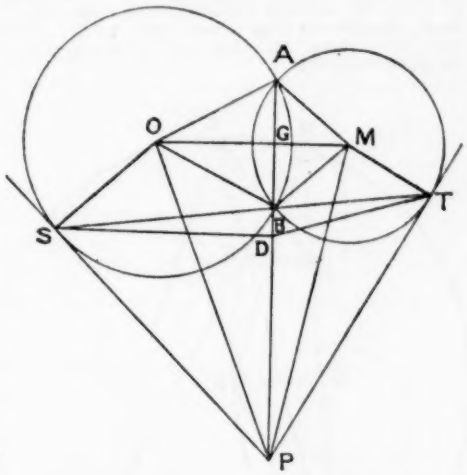
Let AC be larger circle, BD be smaller circle, and E the given angle. Let F be the centre of the smaller circle, and S the centre of the larger circle.



Bisect the given angle by the line EG. At any point on one of the lines containing the given angle erect a perpendicular HK = the radius of the smaller circle. Draw KL parallel to HE, to meet EG in L. Draw LM parallel to HK, to meet EH in M. Then ELM is a triangle, right angled in M. From F, with radius EL, cut the circumference of the greater circle in O. From O draw tangents OP, OQ to the smaller circle, touching it in P and Q. Join FP, FQ, FO. Then each of the angles OPF, OQF is a right angle. In the triangle OPF, EL = OF (constr.), ML = HK, which was made = FP, and each of the angles at P and M is a right angle, then, by I. 47, OP = EM, and angle POF = LEM.

The tangent OQ may easily (I. 47.) be proved = tangent OP. Hence the angle FOQ = POF = LEM. But LEM = half the given angle. Then angle POQ = angle E. The construction will be possible so long as the line EL is long enough to reach the circumference of the outer circle, but not so long as in every position to fall outside of it. It will reach the circumference of the larger circle if it is not shorter than FT, the shortest distance from the centre of the smaller circle to the circumference of the larger. This is got by joining the centres S and F, and producing the line SF to meet the circumference of the larger circle in T.

James Stirling (*Glasgow*).—Let two circles intersect in A and B. In AB produced find a point P, such that, if tangents are drawn from P to touch the circles in S and T, the straight line joining S and T may pass through B.



Let O be centre of larger, M centre of smaller circle. Join OM and MB. At O make OS parallel to BM. At S draw tangent to larger circle, and produce it to meet AB produced in P. From P draw PT, a tangent to the smaller circle. Join SB, BT. Then these two straight lines shall be in the same straight line. Join OB, OA, AM. Let OM, AB intersect in G. Join OP, PM, MT.

Because, in the two triangles OAM and OBM the respective sides OA, AM are equal to OB, BM, and OM is common, the angle BOM = the angle AOM. Because, AO = OB, and OG is common to the two triangles, and the angle BOG = the angle AOG, then each of the angles OGB, AGO is a right angle.

By Euc. II. 12, $OP^2 = OB^2 + BP^2 + 2PB.BG.$

By Euc. I. 47, $PS^2 = OP^2 - OS^2$
$= OP^2 - OB^2$
$= (OB^2 + BP^2 + 2PB.BG) - OB^2$
$= BP^2 + 2PB.BG.$

By Euc. II. 12, $PM^2 = PB^2 + BM^2 + 2PB.BG.$

By Euc. I. 47, $PT^2 = PM^2 - MT^2 = PM^2 - BM^2$
$= (PB^2 + BM^2 + 2PB.BG) - BM^2$
$= BP^2 + 2PB.BG.$

$\therefore PS^2 = PT^2$ and $PS = PT.$

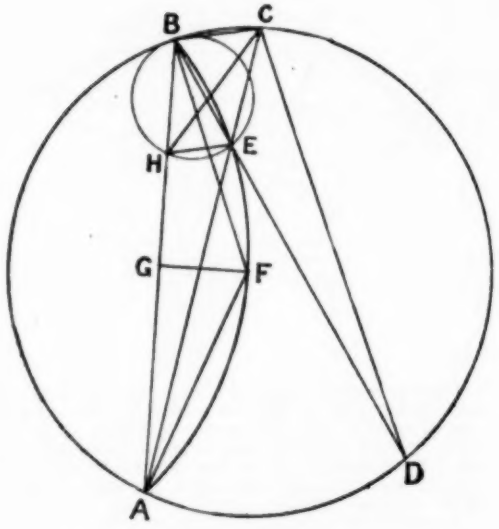
By Euc. I. 32, Cor. 1, the interior angles of the five-sided figure PSOMT = together six right angles. But PSO = a right angle, PTM = a right angle, and the angles SOM + OMB together = two right angles. Then PSO + PTM + SOM + OMB together = four right angles. $\therefore$ The remaining angles BMT + SPT = two right angles. But BMT + MBT + BTM = two right angles. $\therefore$ SPT = MBT + BTM.

Now, if SBT be not the straight line between S and T, if possible, let it occupy some other position, as SDT. Then PSDT is a triangle. And the side PS has been proved equal to PT. Then the angle PSD is equal to angle PTD. The three angles PSD, PTD, SPT are equal to two right angles; that is, they are equal to the three angles BMT, MTB, MBT. But SPT has been proved equal to the sum of MBT and BTM. Then PSD, PTD are together equal to BMT, and, since they are equal, each of them equals one half of BMT. But, because PT is a tangent to the smaller circle, the angle BTP equals the angle in the alternate segment of the circle (III. 32) or one half the angle BMT, which is the angle at the centre. But the angle PTD has been proved equal to one half of BMT. Then the angle PTD = the angle BTP, the less angle equal to the greater, which is impossible. Then SDT is not a straight line. In a similar way it may be proved that the straight line joining S and T can occupy no other position than SBT. Therefore SBT is a straight line.

James Stirling (*Glasgow*).—A, B are two points on the circumference of a circle; AC and BD are chords intersecting at E; show

how to draw the chords so that AE may be three times EC, and DE three times EB.

By Euclid III. 35, the rectangle AE.EC will be equal to the rectangle DE.EB. Now if AE = three times EC, and DE = three times EB, the rectangle AE.EC = three times EC^2, and the rectangle DE.EB = three times EB^2. Since these rectangles are equal to each other, $3\,EC^2 = 3\,EB^2$, and EB = EC. Hence AE = DE, and the whole chord AC = the whole chord DB.



Join AB, and join A and B with F, the centre of the circle. From F drop a perpendicular FG on the chord AB. By Euclid III. 3, GB is the half of AB. Bisect GB in H. On the straight line AB describe a segment of a circle containing an angle equal to the angle AFB, and on the straight line BH describe a segment of a circle containing an angle equal to the angle BFG, cutting the segment containing the angle AFB in the point E (III. 33). Join AE and produce AE to meet the circumference of the circle in C. Join BE, and produce it to meet the circumference of the circle in D. Then AE = 3EC, and DE = 3EB. Join BC. Since BFA is the angle subtended at the centre of the circle by the chord AB, it is double the angle at the circumference (III. 20), that is, it is double of the angle ACB. But it can easily be proved that the angle BFA is bisected by the perpendicular FG dropped on AB. Then the angle BFG equals the angle ACB. But the angle AEB = AFB (III. 21), and the angle BEH = BFG (constr.). Then, since BFG = ½ BFA, BEH = ½ AEB. Since AEB = AFB, and AFB = twice ACB, AEB = twice ACB. But AEB = ECB + CBE (I. 32). Then since ECB or ACB = ½ AEB, CBE also = ½ AEB, and ECB = CBE. Then the side FC = the side EB (I. 6). Join HC. Since HB = ¼ AB (constr.), the triangle HCB is one-fourth of the whole triangle ACB (I. 38). But since the angle BEH = ½ the angle AEB, the remaining angle AEH also = ½ the angle AEB. It therefore equals the angle ACB. Then, by Euclid I. 28, HE is parallel to BC. Therefore the triangle BEC equals the triangle HCB (I. 37). But the triangle HCB has been proved = one fourth of the whole triangle ACB. Therefore the triangle BEC is one fourth of the whole triangle ABC. Hence CE is one fourth of AC, or AE = three times EC. Since the angle CBE has been proved equal to the angle ECB or ACB, the side CD equals the side AB (III. 26). And the angle BAC equals the angle BDC (III. 21). Then in the two triangles ABC, BCD, because BC is common, and the two angles ACB and BAC in the one side are equal to the two angles CBD or CBE and BDC, the side BD equals the side AC (I. 26). But EB has been proved equal to EC, and EC has been proved equal to one fourth of AC. Therefore EB is one fourth of DB, or DE = three times EB. And AE has been already proved equal to three times EC.

OUR PUPIL TEACHERS' AND SCHOLARSHIP COURSE.

BY ARTHUR T. FLUX,

Head Master of the Belvedere Pupil Teachers' Centre, First on Scholarship List, Author of 'Scholarship School Management.'

PUPIL TEACHERS' COURSE.

SCHEME OF WORK FOR THE MONTH.

A.—*English.*

First Year.

1. *The Conjunction.*—Beach, 89–94; Daniel, 120–124. Learn a good classification both of etymology and of function.
2. Finish the Latin suffixes, with meanings and examples.
3. Learn 50 Latin roots and meanings from Beach, Daniel, or any good list.
4. Gray's 'Bard.' Prepare lines 76–110. Learn meanings of all allusions and references, and be prepared to analyse any part and parse any word.

See note below.

Second Year.

1. Prepare thoroughly the syntax of the Verb (Beach, 109–118; Daniel, 191–204). This is a most important section of grammar, and needs very careful attention.
2. Revise any prefixes not thoroughly known.
3. Learn 50 Latin roots and meanings from Beach, Daniel, or any good list.
4. 'The Traveller.' Prepare lines 145–334. Learn meaning of all allusions. Be prepared to paraphrase and analyse any part and parse any word.

Third Year.

1. Learn brief lives of the following authors and a list of their chief works:—Milton, Clarendon, Butler, Bunyan, Dryden, Newton, Defoe, Swift, Steele, Addison, Pope, Richardson, Thomson, Fielding, and Johnson.
2. Learn the Figures of Speech, Rules for Punctuation, and the means of distinguishing words of English from those of foreign origin.
3. Learn 50 roots, with meanings and examples.
4. 'Essay on Man.' Prepare lines 113–232. Endeavour to follow the arguments. Be sure that you are able to paraphrase and analyse any part and parse any word.

See note below.

If any difficulty is experienced, write for assistance.

B.—*Arithmetic.*

First Year.

Boys.—Work:—Lock, Example LXXIV.; Barnard Smith, Example XLVII., Sections 1 to 6; Dixon and Beach, Example XXII.

Girls.—Work:—Dixon and Beach, Examples X*a* and X*b*; Lock, Example XXXVII.

Second Year.

Boys.—(1) Read up 'Theory of Stocks,' and learn definitions of all terms used with regard to them.

(2) Work:—Dixon and Beach, Example XXV.; Lock, Example CXXXVI.; Barnard Smith, Example LXII.

Girls.—Read up Division into Proportional Parts. Work Example XXVIII., Dixon and Beach.

Note especially the method when the ratios are expressed by fractions; *e.g.* divide £134 into 4 parts in proportion to ½, ⅓, ¼, ⅕.

First reduce the fractions to a common denominator.

$$\frac{30 \;.\; 15 \;.\; 12 \;.\; 10}{60}$$

Then, neglecting the denominator, divide in proportion to 30 : 15 : 12 : 10.

Then the first will be $\frac{30}{87}$ of £134 = £60, etc.

Another very common form is where the shares have to be multiplied by another factor; *e.g.* A puts £500 into a business for 6 months, B £800 for 4 months, and C £200 for a year. How should a profit of £4,300 be divided among them?

Now,

A's £500 for 6 months is equivalent to £3,000 for 1 month;
B's £800 for 4 ,, ,, ,, £3,200 ,, 1 ,,
C's £200 for 12 ,, ,, ,, £2,400 ,, 1 ,,

(*Continued on page 46.*)

Our Science Section.

ORGANIC CHEMISTRY NOTES.

BY J. T. HEWITT, M.A., D.SC., PH.D.,

Professor of Chemistry, People's Palace Technical Schools.

In the closed-chain compounds hitherto considered, the ring has always consisted of six members; these, as we have seen, may be all carbon atoms, as in benzene, or there may be one or more nitrogen atoms taking the place of carbon atoms, as in pyridine, the diazines, triazines, etc. Of late years many closed-ringed compounds have been prepared, in which instead of six members, five, four, or even only three, atoms take part in the ring building; there is no doubt, however, that the five- and six-membered rings are the most stable and are preferentially formed. Thus three molecules of acetylene may condense to form one molecule of benzene, whilst very many acetylene derivatives condense spontaneously to corresponding benzene derivatives. The reason of this greater stability of the five- and six-membered rings was first explained ten years back by Baeyer, in his now famous 'Spannungs-Theorie,' which refers the phenomena to stereochemical data. (*Ber.* 18. 2277.)

In the exposition of his theory, Baeyer starts with the generally received laws as to the affinities of carbon atoms, which are as follows:—

1. Carbon is as a general rule tetravalent.

2. These valencies are equal to one another in value; *e.g.* there is only one chlormethane, one brommethane, etc.

3. The four valencies are symmetrically disposed in space and correspond to the corners of a regular tetrahedron inscribed in a sphere.

4. These valencies do not change places with one another except under external influences. The proof consists in the fact that a substance of the general formula Cabcd can exist in two modifications.

5. Carbon atoms can link themselves to one another by one, two, or three valencies.

6. The carbon compounds form either open or closed-ring chains.

In addition to these generally received rules Baeyer adds a seventh.

7. The four valencies of a carbon atom act along the directions joining the centre of the tetrahedron with the corners of the tetrahedron, and make with one another angles of 109° 28′.

The direction of the attraction can, however, experience a deviation; this, however, gives rise to a tension which increases with the magnitude of the deviation.

If one considers the various polymethylene compounds of the general formula $(CH_2)_n$, one will notice that the deviations of the affinity directions vary, and it is easy to calculate what the deviation of each axis must be, if we assume that each axis experiences an equal deviation. Thus in ethylene (dimethylene), where we have two carbon atoms united by a 'double-bond,' each of the axes must have undergone a deviation of $\frac{109° 28'}{2}$; in trimethylene, which we can look on as an equilateral triangle, each axis must have been bent through

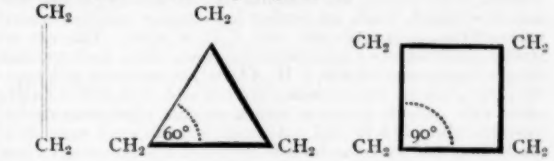
$$\frac{109° 28' - 60°}{2} (= 24° 44');$$

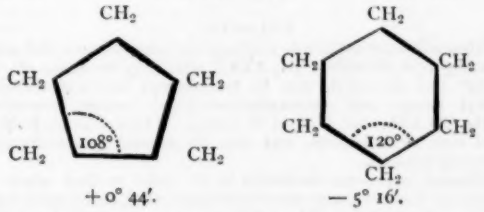
whilst in the cases of tetramethylene, pentamethylene, and hexamethylene the deviations must be respectively

$$\frac{109° 28' - 90°}{2} (= 9° 44'), \frac{109° 28' - 108°}{2} (= 0° 44'),$$

and $$\frac{109° 28' - 120°}{2} (= -5° 16').$$

Thus the pentamethylene and hexamethylene compounds would probably be more stable than the others as the deviation of the direction of the axes is here least; this will be rendered clear by a consideration of the following diagrams:—





The theory corresponds very well with observed facts, dimethylene, forming the weakest ring, being opened up by addition of hydrogen bromide, bromine, and even iodine; trimethylene is opened up by hydrobromic acid, but not by bromine; whilst the tetra- and hexamethylene rings are difficult to break.

Baeyer notices that objection may be raised in that six-membered rings are more frequently found than those containing five atoms; however, it has to be remembered that the six-membered rings are generally derivatives of benzene, a compound less rich in hydrogen than hexamethylene, and it is quite possible that the benzene ring is both more easy to build and more stable than pentamethylene.

Trimethylene, C_3H_6, was first prepared by Freund, who heated trimethylene dibromide, $CH_2Br.CH_2.CH_2Br$, with sodium. It is a gas and differs from propylene, $CH_3.CH=CH_2$, in that it is not attacked by potassium permanganate; it unites with hydrogen iodide, forming normal propyl iodide, but with bromine only with difficulty. Trimethylene bromide itself can be prepared by the addition of hydrogen bromide to allyl bromide:—

$$CH_2=CH.CH_2Br + HBr = CH_2Br.CH_2.CH_2Br.$$

Our knowledge of closed carbon chains has been very greatly extended by the brilliant work of W. H. Perkin, jun. His papers have appeared in the *Berichte* and the *Journal of the Chemical Society* during the past ten years, and are very numerous; a mere sketch of the methods he has adopted in the synthesis of closed chains can be given here. When ethylene dibromide is allowed to act on sodio-malonic ether (prepared by adding malonic ether to absolute alcohol, in which the calculated amount of sodium has been dissolved), the reaction follows two courses; in one case we have a derivative of trimethylene (cyclopropane), in the other a butane derivative produced.

1. $$\begin{matrix}CH_2Br\\|\\CH_2Br\end{matrix} + 2NaCH(COOC_2H_5)_2 = 2NaBr + CH_2(COOC_2H_5)_2$$
$$+ \begin{matrix}CH_2\\|\\CH_2\end{matrix}\!\!>\!C(COOC_2H_5)_2.$$

2. $$\begin{matrix}CH_2Br\\|\\CH_2Br\end{matrix} + 2NaCH(COOC_2H_5)_2 = 2NaBr$$
$$+ \begin{matrix}CH_2-CH(COOC_2H_5)_2\\|\\CH_2-CH(COOC_2H_5)_2\end{matrix}$$

The ethyl butane-tetracarboxylate formed according to the second reaction may be converted into a tetra-methylene compound by acting on its disodium derivative with bromine:—

$$\begin{matrix}CH_2-CNa(COOC_2H_5)_2\\|\\CH_2-CNa(COOC_2H_5)_2\end{matrix} + Br_2 = 2NaBr + \begin{matrix}CH_2-C(COOC_2H_5)_2\\|\\CH_2-C(COOC_2H_5)_2\end{matrix}$$

By hydrolysis of the resulting ethyl ester, tetramethylene-tetracarboxylic acid may be prepared, which on heating loses two molecules of carbon dioxide, giving tetramethylene dicarboxylic acid,

$$\begin{array}{l} CH_2-CH-COOH \\ | \quad\quad | \\ CH_2-CH-COOH. \end{array}$$

A large amount of information on the tetramethylene compounds is to be found in a paper by Perkin and Sinclair in the Chemical Society's Journal for 1892 (*Trans.* 61. 36). When trimethylene dibromide acts on sodio-malonic ether the chief product is ethyl pentane-tetracarboxylate; however diethylic tetramethylene dicarboxylate is also formed, and from this the corresponding dibasic acid may be obtained, which on heating loses carbon dioxide, forming tetramethylene-monocarboxylic acid, $C_4H_7.COOH$. This can be readily converted into a monobrom-derivative, which, however, does not give the unsaturated acid, $C_4H_5.COOH$, on treatment with aqueous potash, but the corresponding hydroxy acid, $C_4H_6(OH)COOH$; whilst with alcoholic potash or sodium ethylate, ethoxytetra-methylenecarboxylic acid is formed. Attempts at splitting of water from the hydroxy acid were also fruitless, sulphuric acid removing carbon monoxide, probably with formation of ketotetra methylene,

$$\begin{array}{l} CH_2-CH_2 \\ | \quad\quad | \\ CH_2-CO \end{array}$$

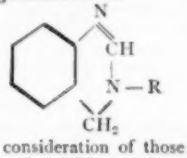
Tetramethylene carboxylic acid may be converted into the corresponding acid chloride, $C_4H_7.COCl$, which, by the action of zinc-methyl and zinc-ethyl, may be transformed into tetramethylene methyl ketone and tetramethylene ethyl ketone respectively ($C_4H_7.CO.CH_3$ and $C_4H_7.CO.C_2H_5$). These ketones yield the usual sorts of derivatives, and may be reduced to corresponding secondary alcohols.

Although a pentane derivative is the chief product when trimethylene dibromide acts on sodio-malonic ether, yet by the action of ethylene dibromide on this sodium compound, ethyl trimethylene dicarboxylate is the chief product, ethyl butane-tetracarboxylate forming only about three per cent. of the product; the yield of this second substance may, however, be raised to 30 per cent. by employing ethylene dichloride instead of the dibromide (*Ber.* 26. 2243). The reaction of tetra- and penta-methylene dibromides on sodio-malonic ether has also been studied, giving results of a corresponding nature; from the pentamethylene compound hexamethylene carboxylic acid (hexahydrobenzoic acid) was obtained, and also ethyl heptanetetracarboxylate; from the latter compound Haworth and Perkin were unable to obtain heptamethylene derivatives by the action of bromine. In fact, seven-membered rings are difficult, and in most cases impossible to form, thus Paal and Bodewig (*Ber.* 25. 2896) were unable to effect splitting of water according to the equation,

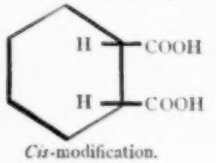
$$C_6H_4\begin{array}{l}NH_2 \\ CH_2-N-C_6H_5\end{array}\begin{array}{l}NH.COH \\ | \\ \end{array} = H_2O$$

$$+ C_6H_4\begin{array}{l}N=CH \\ CH_2-N-C_6H_5\end{array}\!\!>NH$$

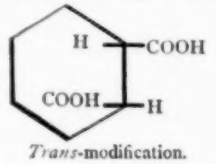
i.e., to produce a seven-membered ring, although in the corresponding case of the formyl derivatives of the o-amido-benzylamine bases such a reaction takes place easily, with formation of dihydro-quinazoline derivatives of the general formula—



Before passing on to a consideration of those compounds which contain an aromatic nucleus in addition to the polymethylene ring, the stereoisomerism observed in this group should be mentioned. In the case of hexahydrophthalic acid, Baeyer found that two modifications existed, which may be distinguished as *cis-* and *trans-*hexahydrophthalic acids. In the first case the two carboxyl groups both lie on one side of the plane of the hexamethylene ring, in the second on opposite sides, thus corresponding to maleic and fumaric acids. Diagrammatically the compounds may be represented as—



Cis-modification.



Trans-modification.

Both forms correspond to anhydrides, $C_6H_{10}(CO)_2O$, although in the case of maleic and fumaric acids we only know an anhydride corresponding to the former, or *cis-*, modification. Perkin has somewhat recently (June 1894) shown that tetramethylene-dicarboxylic acid behaves in a similar way; the acid obtained by heating tetramethylene-tetracarboxylic acid, and melting at 138°, being the *cis*-modification; heating with acetyl chloride removes the elements of water, forming an anhydride, $C_4H_6(CO)_2O$, which when dissolved in water reproduces the original acid. If, however, the *cis-* acid be heated with concentrated hydrochloric acid to 190°, the *trans-* acid is produced, which melts at 131°. In the same way pentamethylene-dicarboxylic acid, $C_5H_8(COOH)_2$, has been found in two modifications.

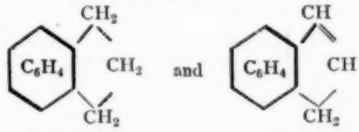
Another important result recently arrived at by Perkin (December 1894) has been the conversion of tetramethylene compounds into dihydrotetrene derivatives, *i.e.*, compounds derived from dihydrotetrene, C_4H_6, the name tetrene being used for the closed ring compound C_4H_4. Thus if methyl dibromtetramethylene-dicarboxylate be boiled with potassium iodide in a solution in absolute alcohol, potassium bromide is formed, whilst free iodine separates according to the equation—

$$\begin{array}{l} CH_2-CBr-COOCH_3 \\ | \quad\quad | \\ CH_2-CBr-COOCH_3 \end{array} + 2KI = 2KBr + I_2$$

$$+ \begin{array}{l} CH_2-C-COOCH_3 \\ | \quad\quad || \\ CH_2-C-COOCH_3 \end{array}$$

The acid corresponding to this methyl ester loses water if heated to 190°–200°, the anhydride, $C_4H_4(CO)_2O$, being produced.

Amongst the mixed aromatic and polymethylene derivatives must be mentioned the two hydrocarbons—



Hydrindene. Indene.

Indene is found in crude benzene; it was isolated from the fraction, boiling at 176°–182°, by Krämer and Spilker, who separated it as its picrate. Indene is a colourless oil, slightly heavier than water, and boiling at 180°.

Closely related to this hydrocarbon is a second one, hydrindene, which may be obtained from indene by reducing it with sodium in boiling alcoholic solution (Krämer and Spilker). Several derivatives of this hydrocarbon were prepared some years back (*Ber.* 17. 125) by von Baeyer and W. H. Perkin, jun., by means of the malonic ether synthesis; when sodio-malonic ether is acted on by orthoxylylene dibromide, ethyl hydrindene-dicarboxylate is formed according to the equation—

$$C_6H_4\begin{array}{l}CH_2Br \\ CH_2Br\end{array} + 2CHNa(COOC_2H_5)_2 = 2NaBr$$

$$+ CH_2(COOC_2H_5)_2 + C_6H_4\begin{array}{l}CH_2 \\ CH_2\end{array}\!\!>C(COOC_2H_5)_2$$

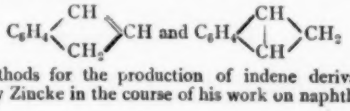
From this compound the corresponding dicarboxylic acid can be prepared; on heating it loses a molecule of carbon monoxide with formation of the acid—

$$C_6H_4\begin{array}{l}CH_2 \\ CH_2\end{array}\!\!>CH.COOH$$

Recently, Perkin (*Jour. Chem. Soc.*, 65. 228) has again taken up the synthesis of indene and hydrindene derivatives by this method, and finds that if the above hydrindene-monocarboxylic acid is decomposed by heating its barium salt alone, or with sodium methoxide, the hydrocarbon formed is not hydrindene, but indene, a molecule of hydrogen having also been split off.

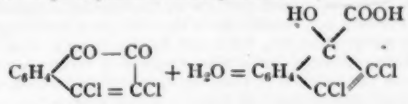
$$C_6H_4 : C_3H_5COOH = C_6H_4 : C_3H_4 + CO_2 + H_2.$$

The indene so obtained differs in physical properties from that produced by Krämer and Spilker from coal tar, although both indenes give the same hydrindene on reduction; perhaps the isomerism is to be explained by the two indenes possessing the different constitutions—



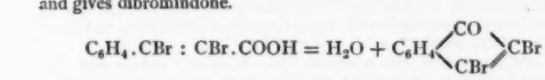
Other methods for the production of indene derivatives were discovered by Zincke in the course of his work on naphthoquinones.

When chlorine is passed into glacial acetic acid, containing 1-amido-β-naphthol in suspension until almost complete solution has taken place, 3 : 4-dichlor-β-naphthoquinone is formed; this latter substance, when treated with cold dilute caustic soda, yields the sodium salt of dichlorhydroxyindene-carboxylic acid.



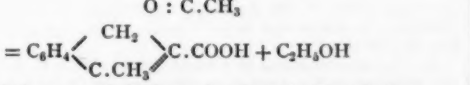
(*Ber.* 19. 2493).

Roser has also worked at the synthesis of indene derivatives; dibromcinnamic acid when treated with sulphuric acid loses water, and gives dibromindone.



This substance forms orange needles, melting at 123° (*Ber.* 20. 1273).

Roser also found that γ-methylindene-β-carboxylic acid might be obtained from ethyl benzyl acetoacetate by splitting off alcohol under the influence of sulphuric acid (*Annalen.* 247. 157).



This acid gives γ-methylindene when heated with soda lime.

Questions—Advanced.—1. If given acetamide, describe and explain the method by which you could prepare from it methylamine. How would you convert methylamine into trimethylamine? 2. Describe the action of nitrous acid on aniline under various conditions, and the properties of the products. 3. Describe the best method of converting crude anthracene into the pure hydrocarbon, and give details of the method whereby anthracene is converted into anthraquinone. 4. How is monochloracetic acid prepared, and how can it be converted into malonic acid and malonic ether?

Honours.—1. Write an account of the uses to which malonic ether may be put in the synthesis of more complex organic compounds. 2. Give an account of recent researches upon the iodo-derivatives of aromatic hydrocarbons and acids, and indicate the analogy between iodine and nitrogen displayed in the characters of the new compounds. 3. Describe methods by which the synthesis of hydrindene and indene derivatives may be effected. 4. What do you understand by Baeyer's 'Spannungs-Theorie'? Show how the behaviour of polymethylene compounds tends to confirm Baeyer's views.

CHEMISTRY NOTES.

BY W. TATE, A.R.C.S., F.C.S.

Applications of Electro-chemical Methods: Rapid strides have been made in the last few years in the application of electricity to the production of many of the more difficultly prepared substances. Among these, the metals aluminium, manganese, tungsten, chromium, and sodium have especial interest.

Aluminium is now entirely made by the electrolysis of alumina dissolved in fused cryolite ($Na_6Al_2F_{12}$). Powdered bauxite is heated with sodium carbonate for about six hours to convert the alumina present into sodium aluminate. The sodium aluminate is dissolved in water, and thus separated from the insoluble ferric oxide accompanying alumina in bauxite. Aluminium hydrate is precipitated from the solution by passing a current of carbon dioxide, which reproduces the sodium carbonate. The hydrate is then heated to expel water, and the oxide thus produced is added to fused cryolite in the electric furnace. The cryolite simply serves as a medium for dissolving the alumina, and does not itself undergo decomposition in the process. The electrolysis of alumina is thus carried on continuously, and the metal is made much more cheaply than by the old sodium process.

Manganese, tungsten, and chromium are made in some quantity by the same general process for application in steel-making. The oxides of the metals are mixed with carbon, and reduced in the electric furnace at the intense heat produced by the passage of a current of 300 ampères and 60 volts. A carbide is thus produced containing from 8 to 14 per cent. of carbon. This carbon is eliminated by fusion in the same furnace with a further portion of the oxide, the pure metal being then produced.

Chromium is largely made by a purely electrolytic process. A dilute solution of a chromium salt is saturated with salts of the alkalies together with dextrin, and electrolysed by the passage of a current of about 40 volts through the warm solution. The deposition plate is made small in comparison with the plate serving as the point of entry for the current into the solution, so that the resistance may be minimised and yet a high current-density be maintained.

To make chromium-iron alloys, iron salts are added to the chromium solution. As iron can be deposited at much lower voltage than chromium, and as the proportion of chromium increases as the voltage rises, it is quite possible to deposit the two metals in any desired ratio. The iron may be deposited first by a current of low E.M.F., and the chromium subsequently deposited to the extent required by a current of higher E.M.F., the compound plate thus produced being melted down to produce a homogeneous alloy.

Sodium is now made chiefly by Castner's electrolytic process. An output of five or six tons weekly is secured by the expenditure of about 1,000 horse-power. The process is essentially an adaptation of the method by which the metals of the alkalies were discovered. Caustic soda is maintained fused at 313° C., in cells requiring each 1,000 ampères at 4 to 4½ volts. The low temperature favours the process, as the cell resistance is then low, and during the passage of the current the sodium runs off from the top in the molten condition, and all necessity for volatilization of the metal produced is avoided.

Among less important operations of the same nature, it may be noted that magnesium is no longer produced by the sodium process, but, like aluminium, is now made by electrolysis.

The fused double chloride of magnesium and potassium is used for bath, reducing gases being introduced into the electrolytic cell to prevent any chance of the magnesium firing.

The most important compound produced by electrical methods is likely to be calcium carbide, CaC_2. This compound reacts readily with water, producing slaked lime and acetylene gas in accordance with the equation

$$CaC_2 + 2H_2O = CaH_2O_2 + C_2H_2.$$

Acetylene gas has an illuminating power of about 250 candles when burnt at the rate of 5 cubic feet per hour; under similar conditions, ordinary gas averages about 16 candles. The cheap production of this gas, which can be easily transported in the liquid form or made when required from the carbide, will enable many new developments in lighting to be accomplished.

The production of calcium carbide is due to a simple chemical reduction at the extremely high temperature of the electric arc. A mixture of equal weights of carbon and lime is heated in a graphite or carbon crucible supported by an outer casing of masonry, the alternating current which supplies the necessary heat being conducted into the mass by an adjustable carbon pole passing through the carbon cover to the crucible. The cover rests on the masonry walls, and does not come in contact with the carbon crucible, which itself forms the second pole. The dark crystalline mass resulting from the reaction consists of almost pure calcium carbide. It is produced in the way indicated by the equation

$$CaO + 3C = CaC_2 + 2CO.$$

The electrolytic method of manufacturing caustic soda and chlorine liquors has already been mentioned in these columns (see PRACTICAL TEACHER, No. 7, Vol. 13, p. 379).

Large works in Switzerland and Sweden are now actively producing potassium chlorate by the electrolysis of a hot solution of potassium chloride. The caustic potash, chlorine, and oxygen, when allowed to freely intermix, react in accordance with the equation

$$KOH + Cl_2 + O_2 = KClO_3 + HCl.$$

The solution should be electrolysed in metallic vessels, which act as cathodes, anodes being formed of thin sheets of plantinum. It is recommended to enclose the platinum sheets in porous cells in which a solution of potash is circulated, a solution of potassium chloride being at the same time circulated outside. With strong solutions, and a temperature of about 80° C., the caustic potash of the inner cells is gradually transformed into chlorate, the potassium chloride without being simultaneously converted into caustic potash.

The production of phosphorus has been considerably improved by utilization of the heating power of the electric furnace. A mixture of acid calcium phosphate and carbon is heated to a very high temperature between carbon electrodes, and the distilled phosphorus arrested by a suitable condenser. An alternating current of 400 kilowatts is employed, and gives a far more complete reduction than that obtained by the old methods of heating, as the slag retains but a very small proportion of phosphorus as iron silico-carbide, the lime having formed calcium silicate, aluminate, and carbide.

The electrolytic principle has been applied to the production of acids from their salts, chromic acid being produced round the anode and caustic alkali round the cathode separated by a porous diaphragm. The alkali is used in treatment of fresh chrome mineral, and the production of chromic acid thus rendered continuous.

A silicon carbide, CSi, termed carborundum, is produced by placing a mixture of 182 parts sand, 146 parts coke, and 72 parts common salt, in a firebrick lined cavity (6 ft. × 18 in. × 12 in. deep), and supplying current from four carbon electrodes at each end. Eight hours' fusion by the aid of the current from a 100 h.p. dynamo produces about 100 parts of the intensely hard carborundum, which finds a ready sale and application as an abrading agent.

Chloroform of exceptional purity is cheaply and expeditiously produced as follows :—A 20 per cent. solution of sodium chloride is steam-heated in an enamelled-iron retort to the boiling point. The current is passed between lead electrodes suspended in the liquid, and acetone is continuously passed into the solution. The free chlorine produced acts on the acetone with formation of chloroform, which distils off as it is produced.

Valuable pigments also find a place in the list of substances now made electrolytically. Cadmium yellow, CdS, is readily produced by electrolysing a solution of common salt between cadmium electrodes and leading a stream of hydrogen sulphide into the bath. Cadmium sulphide is precipitated as rapidly as cadmium chloride is produced by solution of the plates. By an exactly similar process, antimony vermilion is produced when antimony poles are used.

The production of vermilion has also been accomplished in the wet way as follows :—A bath is prepared containing 8 per cent. of ammonium nitrate and 8 per cent. of sodium nitrate ; in this bath small vessels of mercury are connected with the positive pole of the dynamo, the negative pole being connected with a steeled copper plate. During the passage of the current, hydrogen sulphide is led through the solution, and the vermilion formed is separated by filtration at intervals. By very similar methods, Scheele's green is produced with a sodium sulphate bath and copper electrodes, white arsenic being suspended in the bath ; Prussian blue is made by the electrolysis of ferrous ferrocyanide suspended in a 5 per cent. acid solution.

White lead is produced continuously by leading carbon dioxide into an electrolytic cell containing a 15 per cent. solution of nitric acid, through which a current is being passed between lead electrodes. Another process for the production of lead carbonate employs an ammonium acetate solution ; the anode is separated by a porous partition from the cathode, lead acetate being produced at the former and ammonium hydrate at the latter. The ammonia is converted into carbonate by carbon dioxide and the two solutions mixed, with formation of lead carbonate and regeneration of ammonium acetate.

HONOURS PHYSIOGRAPHY NOTES.

BY A. M. DAVIES, B.SC. (LOND.), F.G.S.,
Late Demonstrator in Geology at the Royal College of Science.

The Origin of Dolomite.

A most important contribution to this vexed question has just been published by a Belgian geologist, M. C. Klement (*Bull. Soc. Belge Géol., etc.*). His paper begins with a summary of previous opinions on the question, the earliest of which was that of Von Buch and others, who suggested a metamorphism of ordinary limestone by volcanic vapours. Although such a change has been shown to occur locally in volcanic regions, it has long been abandoned as inadequate to explain the extensive developments of dolomite among stratified rocks. Later observers have suggested a conversion of limestone into dolomite by the action of magnesium salts in solution in water, the frequent association of gypsum with dolomite suggesting that magnesium sulphate was the chief salt concerned, and that a process of double decomposition gave rise to magnesium carbonate and calcium sulphate simultaneously, the former uniting with the excess of undecomposed calcium carbonate to form dolomite. The difficulty of this explanation lay in the fact that experiments show that the chemical action only takes place at temperatures above 100° Centigrade, and that below that point such slight action as does take place is of the opposite nature (*i.e.*, gypsum and dolomite tend to interact on one another with formation of calcium carbonate and magnesium sulphate). Moreover, it leaves unexplained the source from which the salts of magnesium were derived.

A totally different theory has been based on the fact that a small quantity of magnesium carbonate is always found associated with the calcium carbonate of animal skeletons ; it was suggested that the excess of the calcium carbonate might be dissolved away either by the sea-water (when a deposit of dolomite would be formed without any further metamorphosis), or, as Bischof suggested, by percolation of ordinary rain-water through limestones, after deposition. This last theory probably applies in the case of the porous dolomites known as *cargneules*, and perhaps to the English magnesian limestone of Permian age, which shows signs of great shrinkage accompanied by recrystallization, but it can hardly apply to massive dolomites. Other theories have also assumed a direct deposition of dolomite on the sea-floor by chemical interactions between waters of different composition (sea and river or spring waters).

None of these seem sufficient to explain the extensive and thick masses of dolomite that occur in many geological formations—such, for example, as those of the Tyrol. No doubt, in particular local developments of dolomite, we may have cases explicable on one or other of these theories, but the most important cases seem to require further explanation.

The difficulty of the problem, M. Klement points out, has hitherto been this—that while we have in the salts of sea-water an ample and natural source for the magnesium required to convert limestone into dolomite, we cannot conceive how the temperature required for the action can be obtained in the case of sea-water. He has been struck, however, by the following well-known but not fully appreciated facts :—

1. The very general occurrence of dolomite in the form of coral reefs, and especially of atolls. This has been pointed out in the Devonian reefs of the Ardennes by Dupont, in the Permian of Thuringia by Liebe, and in the Triassic of the Tyrol by Richthofen and Mojsisovics.

2. The dolomitization of a modern atoll (Metia in the Pacific) on the side facing the lagoon, as described by Dana, who found that while in the unaltered coral there was only a trace of magnesium, 38 per cent. of magnesium carbonate was present in the coral rock margining the lagoon. Dana ascribes the difference to the chemical action of the saturated waters of the lagoon.

3. The fact, pointed out by Dana and confirmed by Sorby, that coral is composed, not of *calcite*, but of *aragonite*.

These considerations, he suggests, may explain the failure of chemists to produce artificial dolomitization below a temperature of 100° C., since their experiments were all made on *calcite*, while the chemical properties of *aragonite* are different. He has, therefore, carried out a large series of experiments in accordance with this view. The following are his chief results :—

1. From about 60° C. upwards, magnesium sulphate in the presence of a saturated solution of sodium chloride, acts upon aragonite with formation of magnesium carbonate. The action increases with the temperature and length of time, there being apparently a maximum of production for every temperature (for 91° this maximum is 42 per cent. of magnesium carbonate, which is very near the 45·7 per cent. of normal dolomite).

2. Concentration of the solution is essential for any extensive action, the percentage of magnesium carbonate produced falling rapidly with the addition of water. This is not only due to the *relative* amount of sulphate and water, but to the *absolute* amounts, for a large volume of the proper solution is much inferior in action to a small volume. This is probably owing to the necessity for the *precipitation* of the slightly soluble calcium sulphate to enable the reaction to continue, the precipitation being retarded by increase of volume of the liquid.

3. The absence of sodium chloride greatly diminishes the extent of the action.

4. Chloride of magnesium is much inferior to sulphate in its action. This is explained in accordance with the last given explanation, by the fact that no insoluble salt of calcium is produced.

5. *Calcite* is, under the same conditions, attacked very slightly.

6. Ordinary coral (containing already ·3 to ·4 per cent. of magnesium carbonate only) is acted upon in precisely the same way as mineral aragonite.

7. The exact composition of the product of the reaction is difficult to determine, owing to the impossibility of isolating it from the residual aragonite. It is not, however, *dolomite*—$CaMg(CO_3)_2$—but a hydrous neuter carbonate of magnesium, perhaps $MgCO_3$, H_2O.

The questions which next arise concern the occurrence of this reaction in nature, and the possibility of the conversion of the mixture of residual aragonite and hydrous magnesium carbonate into actual dolomite.

As to the first, the most favourable conditions are to be found in *closed* atolls, *i.e.*, atolls whose lagoons are quite shut off from the sea except at high tides and in stormy weather. In such cases the temperature of the water can rise very high ; for coral reefs are confined to the tropics, and observations have shown that the reef rock itself may have a temperature as high as 84° C. It is also known that the lagoon water may become highly concentrated by evaporation,

and even completely dried up. Moreover, the lagoon floors are covered by a calcareous mud, formed largely of the *débris* of the aragonite skeletons of the corals. All the necessary conditions, including of course the presence of sodium chloride and magnesium sulphate, both abundant in sea-water, may easily be satisfied in this case. There are other possible cases; isolated lagoons may be formed between the coast and a barrier reef. Corals are not the only suitable skeletons; many mollusca also have aragonite shells, and along low coast-lines there may be formed isolated sheets of salt water, which may undergo evaporation. In such cases there will be a large proportion of calcite mixed with the aragonite, and dolomitic limestone, rather than true dolomite will be formed. These last conditions, it is suggested, seem to have been present in the case of some Permian dolomitic limestones.

As regards the second question, the author points out many evidences of the comparative facility with which dolomite recrystallizes, so that there is no difficulty in accounting for the necessary change from the condition of a mixture of carbonates.

While therefore dolomite may have been formed in several ways, the most important method is probably by the action of concentrated sea-water on aragonite skeletons (particularly corals) at the time of deposition.

Calcite and Aragonite Shells.

Much attention has been drawn to the question of the nature of calcareous shells, more especially by Sorby and Kendall. Its special importance lies in the fact that calcite is a far more stable form of calcium carbonate than aragonite, which readily undergoes solution and decomposition. Thus organisms which form aragonite skeletons are less likely to be preserved as fossils than those which form calcite. The following are the chief aragonite-forming classes of animals:—Among the Foraminifera the Imperforata, most Corals, the external layer only of calcareous Polyzoa, Lamellibranchia (either the whole shell or the inner layer only), most Gastropoda, Cephalopoda (except the 'guard' of Belemnites). In most other groups, and the exceptions indicated above, calcite is present, generally as an aggregate of fibrous crystals: in Echinodermata, however, each separate plate of the skeleton is formed of calcite with complete crystalline continuity, *i.e.* is a single (allotriomosphic) crystal of calcite.

Geological Occurrence of Radiolaria.

To the formations in which abundant radiolarian remains are known in England must now be added the Carboniferous. In a paper just read to the Geological Society, Dr. Hinde and Mr. Fox announce the discovery of a well-marked horizon of radiolarian cherts extensively developed in the Lower Culm Measures of Cornwall, Devon, and West Somerset. These beds had hitherto been regarded as grits, very barren of fossil remains. The present discovery tends to show that the Culm Measures of the Devonshire area is a deep-water equivalent of the Carboniferous Limestone of more northern parts of England.

Overthrusts of late Geological Age.

Some valuable discoveries as to earth-movements of various dates have been obtained by Mr. Strahan, of the Geological Survey, in the course of mapping South Dorset on the scale of 6 inches to a mile. He has been able to discriminate between disturbances of Cretaceous and others of Tertiary age. The features produced by the former series were planed down before the deposition of the upper Cretaceous sediments, while those of the latter have determined the existing features and drainage system of this area and the Isle of Wight. Among the disturbances specially mentioned are thrust-planes which have carried Lower Cretaceous over Upper Cretaceous beds, and Lower Oolites over Upper Oolites and Cretaceous. In another case a synclinal of the first date has had an anticlinal of the later date superimposed on it.

MAGNETISM AND ELECTRICITY.

FOR THE ADVANCED STAGE OF THE SCIENCE AND ART DEPARTMENT COURSE.

BY EDWIN EDSER, A.R.C.S.

Assistant in the Physical Laboratory, Royal College of Science; Member of the Physical Society.

THE Science and Art Examination in Electricity and Magnetism held during May last shows more markedly than ever the value set by the examiners on a quantitative or mathematical knowledge of the subject. The following model answers to the questions set may help the student to gauge his chance of success in the late examinations, or to a fuller success on some future occasion.

Magnetism.

'A magnet is placed so that its centre is due magnetic east of the centre of a compass needle which is so mounted that it cannot dip. The magnet is made to rotate in a vertical plane about a horizontal axis which lies east and west and passes through its centre. Describe the behaviour of the compass needle during one complete revolution of the magnet.'

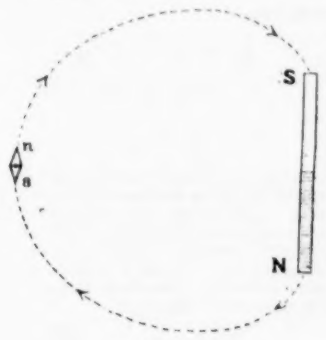


FIG. 1.

Let *ns* represent the compass needle, and SN the magnet placed due east of it, with its S pole (say) pointing towards the magnetic north. Then the lines of force due to the earth's field will pass through the compass needle from *s* to *n*; and since the lines of force of a magnet leave it at the N pole, and finally re-enter at the S pole, those due to NS (such as are represented by the dotted line) will pass through the compass needle from *s* to *n*, thus reinforcing the earth's horizontal magnetic field. No deflection of the needle will occur; but since the time of vibration of a compass needle varies inversely with the square root of the controlling force, the latter being greater, the period of the needle will become shorter.

Now suppose the magnet NS rotated about the line, joining its centre to the centre of *ns*. When S is vertically above N, no effect will be produced on the compass needle, since the latter cannot dip; *ns* is now virtually under the same conditions as if NS were not present. At intermediate points of the rotation intermediate effects will be produced.

On rotating NS till N is pointing magnetic north, the lines of force from it will pursue the same path as in the first circumstances, but in an opposite direction. They will consequently now *oppose* the earth's horizontal magnetic field; if the pole strength of NS be sufficiently great, or if it be placed near enough to *ns*, it may overcome the earth's field, in which the compass needle will point to the south, otherwise it will weaken the earth's field, and consequently increase the period of oscillation of NS. At intermediate positions the effect will depend on the above conditions. If the latter is fulfilled, a progressive increase in the period of the needle will be all that is to be observed; in the former, an increase of the period will take place till a point is reached when the needle will swing round to the south, after which a decrease in the period will be observed.

On further rotating NS through two right angles to its first position, similar changes, but in inverse order, will be observed.

'An iron pillar stands vertically in the centre of a room in which the direction of the magnetic meridian is known. Assuming that there is no other iron in the neighbourhood, how would you determine what part of the horizontal magnetic force at a given point in the room, magnetic north or south of the centre of the pillar, is due to the pillar?'

The part of the magnetic force north or south of the centre of the pillar can easily be determined from the relation

$$T = 2\pi\sqrt{\frac{K}{F}},$$

where T = time of oscillation of a suspended magnet, when subjected only to a control force proportional to F, and K = moment of inertia of the maguet.

Let the suspended magnet be first set oscillating at a point remote from the pillar; then, if the magnetic force here be proportional to F,

$$T_1 = 2\pi\sqrt{\frac{K}{F}} \quad . \quad . \quad . \quad (1)$$

Now take the suspended magnet to the point north or south of the pillar at which it is required to determine the increase or

decrease of the horizontal field. Let the increase be proportional to f; then, if T_2 be the time of vibration at this new point,

$$T_2 = 2\pi\sqrt{\frac{K}{F+f}} \quad . \quad . \quad (2)$$

Dividing (1) by (2), we get

$$\frac{T_1}{T_2} = \sqrt{\frac{F+f}{F}}.$$

Squaring both sides,

$$\frac{T_1^2}{T_2^2} = \frac{F+f}{F} = 1 + \frac{f}{F};$$

$$\therefore \frac{f}{F} = \frac{T_1^2}{T_2^2} - 1 = \frac{T_1^2 - T_2^2}{T_2^2};$$

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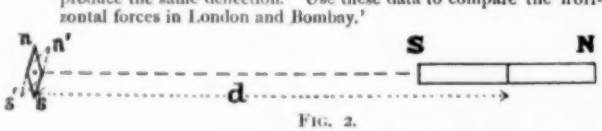
'A short bar magnet is placed on a table with its axis perpendicular to the magnetic meridian, and passing through the centre of a compass needle. In London the compass needle is deflected through a certain angle when the centre of the magnet is 25 inches from the centre of the needle. If the experiment be repeated in Bombay the magnet must be moved 5 inches nearer to the needle to produce the same deflection. Use these data to compare the horizontal forces in London and Bombay.'



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Let distance NS = $2l$, and the pole strength of N or S = m.

First find the force exerted on a unit pole placed at the position of ns.

$$\text{Force due to S} = \frac{m \times 1}{(d-l)^2}$$

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$$= m\frac{(d+l)^2 - (d-l)^2}{(d^2-l^2)^2} = \frac{4mdl}{(d^2-l^2)^2}.$$

Also, since the bar magnet is short, l is small, and l^2 may be neglected in comparison with d^2.

$$\therefore \text{force} = \frac{4mdl}{d^4} = \frac{4ml}{d^3} = \frac{4M}{d^3}.$$

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If now the compass needle be supposed of length l_1 and of pole strength m_1, it will be subjected to a couple

$$= \frac{m_1 l_1 \cos\theta \times 4M}{d^3},$$

where θ is its angle of permanent deflection. Also, the restoring couple due to the earth's field = $Hm_1l_1 \sin\theta$. Since the needle is in equilibrium when deflected through θ, we must have these two couples equal and opposite.

$$\therefore Hm_1l_1 \sin\theta = \frac{4Mm_1l_1\cos\theta}{d^3};$$

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Now let H_1 = Horizontal force at London;
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$$\therefore H_1 = \frac{4M\cot\theta}{(25)^3}, \quad . \quad . \quad . \quad (1)$$

$$H_2 = \frac{4M\cot\theta}{(20)^3}, \quad . \quad . \quad . \quad (2)$$

M and θ remaining the same in both instances, $\therefore$ dividing (2) by (1)

$$\frac{H_2}{H_1} = \left(\frac{25}{20}\right)^3 = \left(\frac{5}{4}\right)^3$$

$\therefore$ Horizontal force at Bombay : Horizontal force at London
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'Attempts have been made to imitate the magnetic state of the earth by putting a magnet inside a globe. Explain why the results are unsatisfactory.'

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Suppose the leaves of an electroscope to be surrounded, as is often the case, by a wire gauze or other metallic cylinder. Then if the leaves and the gauze be at different potentials, lines of force will of course pass from the one to the other. These will contract along their length, and consequently the leaves will be pulled apart.

Supposing now that the leaves of the electroscope are at zero potential, all that is necessary to make them diverge is that an insulated metallic cylinder be placed around them, and the latter be charged; the effect is indeed precisely similar to that which would take place were the leaves charged and the cylinder kept at zero potential.

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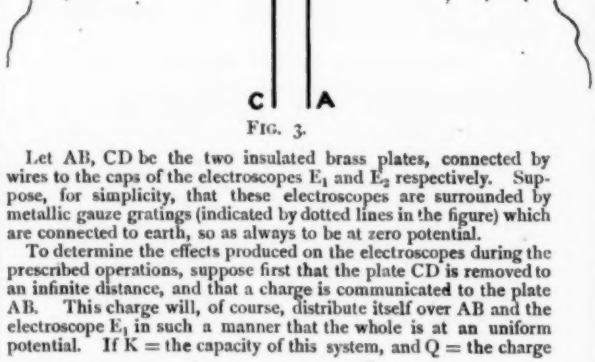

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To determine the effects produced on the electroscopes during the prescribed operations, suppose first that the plate CD is removed to an infinite distance, and that a charge is communicated to the plate AB. This charge will, of course, distribute itself over AB and the electroscope E_1 in such a manner that the whole is at an uniform potential. If K = the capacity of this system, and Q = the charge communicated to it, then the potential $V = \frac{Q}{K}$. Also, the divergence of the electroscope leaves is proportional to V or to $\frac{Q}{K}$.

Now let CD be brought up close to AB. If it were entirely insulated from other conductors, no appreciable effect would be produced; but as it is connected to the leaves of the electroscope E_2, a charge opposite in sign to Q will be induced on it, and an equal and opposite charge will be communicated to E_2. Thus the capacity K of the system AB will be increased, and therefore its potential = V $= \frac{Q}{K}$ will be diminished.

If now a slab of dielectric, of specific inductive capacity = S (greater than 1) be introduced between AB and CD, its effect will be to still further increase the capacity of the system AB, so that a

further diminution of the divergence of the leaves of E_1 will take place.

Now let us turn our attention to the system CD and the electroscope E_2. When CD is at an infinite distance from AB, there will be no divergence of the leaves of the electroscope E_2; but as it is brought up nearer to AB, the whole system will be at the potential of the point of space at which CD is situated. This potential will, therefore, increase with the decrease of the distance between AB and CD, and consequently the divergence of the leaves of E_2 will increase; and as the effect of introducing a slab of dielectric between them is to virtually decrease this distance, the effect of this introduction will be to still further increase the divergence of the leaves of E_2.

To summarize:—Supposing that, with the connections prescribed, the original divergence of the electroscope leaves was zero, the effect of communicating a charge to one of them will be to cause the leaves of both electroscopes to diverge; if the electroscopes had been of such a nature that positive potentials could be discriminated from negative ones, both electroscopes would indicate the same kind of potential. On inserting a slab of shellac between the two plates, the electroscope connected to the slab which received the original charge will show a decrease in potential, whilst the other one will show an increase of potential.

'Equal quantities of positive electricity are communicated to two insulated metallic spheres whose radii are as five to one. What are their relative electrical potentials? The spheres are then put in conducting communication by means of a long thin wire, which is afterwards removed. What are now the relative electrical surface densities of the spheres? State in each case which sphere has the greater potential or surface density.'

If a quantity of electricity Q be communicated to a sphere of radius R, the potential $V = \frac{Q}{R}$. Therefore if equal quantities of electricity be communicated to two spheres of radii as 5 to 1, their potentials will be as 1 to 5, or inversely as their radii. If the two spheres be now put in communication, electricity will flow from the small one to the large one till the potentials are equalized. Let Q_1 be the charge on the sphere of radius 1, then, since the sum of the two charges will be 2Q, the sum of the original charges, the charge on the sphere of radius 5 will be $2Q - Q_1$.

Then we have, in order that the potentials of both may be equal,

$$\frac{Q_1}{1} = \frac{2Q - Q_1}{5};$$

$$\therefore 6Q_1 = 2Q$$

$$Q_1 = \tfrac{1}{3}Q.$$

The quantity of electricity condensed on the sphere of radius = 1, will be $\frac{1}{3}Q$, that on the sphere of radius = 5 being $2Q - \frac{1}{3}Q = 1\frac{2}{3}Q$.

To obtain the surface densities in the two cases we must divide by the area of the spherical surfaces. Since this = $4\pi r^2$, where r = radius of sphere,

Surface density on sphere of radius = 1

$$= \frac{\frac{1}{3}Q}{4\pi \times 1^2} = \frac{Q}{12\pi};$$

Surface density on sphere of radius = 5

$$= \frac{\frac{5}{3}Q}{4\pi \times 5^2} = \frac{Q}{60\pi}.$$

∴ after communication, the surface density of sphere of radius = 1 : surface density of sphere of radius = 5 :: $\frac{1}{12}$: $\frac{1}{60}$ = 5 : 1.

Before communication, of course, the surface densities of the sphere of radius = 1 : surface density of sphere of radius 5

$$:: \frac{Q}{4\pi 1} : \frac{Q}{4\pi \times 5^2} = 25 : 1.$$

'A Leyden jar consists of two concentric spherical surfaces of 5 and 6 cm. diameter respectively, the intervening space being filled with air. The outer sphere is uninsulated, the inner is charged with 20 units of electricity. How much work is done when the inner sphere is put to earth?'

The capactity of a condenser consisting of two spherical surfaces of radii r_1 and r_2 respectively

$$= \frac{r_1 r_2}{r_2 - r_1}.$$

Substituting 5 cm. and 6 cm. for these respective values, we get capacity of condenser

$$\frac{5 \times 6}{6 - 5} = 30.$$

Also $V = \frac{Q}{K}$; ∴ potential of inner coating $= \frac{20}{30} = \frac{2}{3}$.

Moreover, work done in bringing a charge Q to potential V = $\frac{1}{2}$ QV.

∴ Work done in charging condenser = $\frac{1}{2} \times 20 \times \frac{2}{3} = \frac{20}{3}$.

The work done in putting inner coating to earth (*i.e.*, in discharging the condenser) = work done in charging it = $\frac{20}{3} = 6{\cdot}6$ units of work.

'Describe a method of proving that the force between two small electrified bodies varies inversely as the square of the distance between them.'

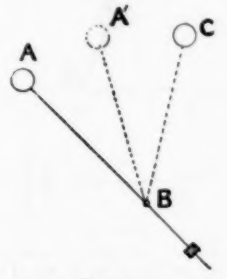

FIG. 4.

This can conveniently be proved by means of Coulomb's torsion balance. A small pith ball A is carried on the end of a piece of capillary glass tube counterweighted at the other end, and the whole is suspended by a fine metallic wire or quartz fibre at B. Another similar pith ball C is carried on a fixed glass rod. Let A and C be now similarly charged: they will repel each other, and in order to bring them to the same position as at first, the torsion head attached to the suspending wire must be turned through an angle θ, say. Now if A and C be at the same distance r from B, we have that the distance between them

$$= 2r \sin \frac{\angle ABC}{2} = 2r \sin \frac{\phi_1}{2}, \text{ if } \angle ABC = \phi_1.$$

Now twist the torsion head till A has approached more nearly to the position of C. Let ϕ_2 be the new angle A'BC. Then distance between A' and C = $2r \sin \frac{\phi_2}{2}$.

Also the torsional force exerted by the twisted wire is proportional to the twist. This was, of course, θ_1 in the first instance, and $\theta_2 - (\phi_2 - \phi_1)$ in the second, if θ_2 be the total angle through which the torsion head has been turned from its primary position. Then it will be found that

$$\frac{\theta_1}{\theta_2 + \phi_1 - \phi_2} = \frac{\left(\sin \frac{\phi_2}{2}\right)^2}{\sin \left(\frac{\phi_1}{2}\right)^2},$$

i.e., that the force exerted between two small electrified bodies varies inversely as the square of their distance apart.

Voltaic Electricity.

'Define unit magnetic pole and unit electrical current in the electro-magnetic system, and state the relation of the ampère to the latter.'

The *unit magnetic pole* is of such a strength that when placed at unit distance from another similar pole, it repels it with unit force.

In the C.G.S. system the unit distance is of course 1 centimetre, and the unit force is 1 dyne, or 1 centimetre per second per second.

Also, *unit field* repels a unit pole placed in it with a force of 1 dyne.

Unit current, when flowing through a wire of unit length (1 cm.), bent into an arc of a circle of unit radius, produces a unit field at the centre of the circle.

The *ampère* is $\frac{1}{10}$ of the C.G.S. unit of current.

'Describe and explain a method of comparing the resistances of two coils of wire having given a battery, galvanometer, wire, and a foot rule.'

The resistances of the two coils of wire may be compared by extemporizing, with the materials prescribed, a Wheatstone's bridge, and then proceeding in the usual way.

The bridge may be extemporized as follows:—Stretch a piece of uncovered German silver wire on a bench between two nails A and B, and connect with copper wires the ends of this to R_1 and R_2, the two coils whose relative resistances are required, the other terminals of these latter being connected by means of a copper wire CD. Join a battery (such as a Leclanché cell) to A and B, and having joined one terminal of the galvanometer to CD, with a wire connected to the other touch along AB till a point is found where no deflection occurs in the galvanometer. Call this point E. Then Resistance of R_1 : Resistance of R_2 :: length AE : length EB. The latter lengths can be measured with the foot rule.

decrease of the horizontal field. Let the increase be proportional to f; then, if T_2 be the time of vibration at this new point,

$$T_2 = 2\pi\sqrt{\frac{K}{F+f}} \quad . \quad . \quad (2)$$

Dividing (1) by (2), we get

$$\frac{T_1}{T_2} = \sqrt{\frac{F+f}{F}}.$$

Squaring both sides,

$$\frac{T_1^2}{T_2^2} = \frac{F+f}{F} = 1 + \frac{f}{F};$$

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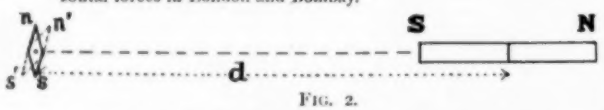

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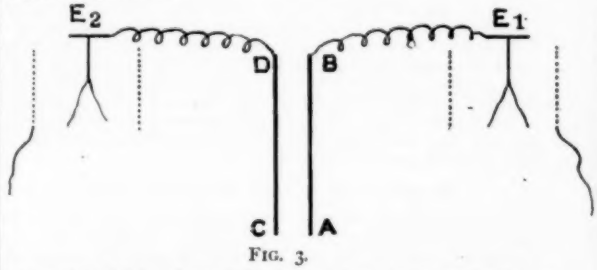

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$$\frac{Q_1}{1} = \frac{2Q - Q_1}{5};$$

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Substituting 5 cm. and 6 cm. for these respective values, we get capacity of condenser

$$\frac{5 \times 6}{6 - 5} = \frac{}{30}.$$

Also $V = \frac{Q}{K}$; ∴ potential of inner coating $= \frac{20}{30} = \frac{2}{3}$.

Moreover, work done in bringing a charge Q to potential V = $\frac{1}{2}$ QV.

∴ Work done in charging condenser = $\frac{1}{2} \times 20 \times \frac{2}{3} = \frac{20}{3}$.

The work done in putting inner coating to earth (*i.e.*, in discharging the condenser) = work done in charging it = $\frac{20}{3} = 6\cdot6$ units of work.

'Describe a method of proving that the force between two small electrified bodies varies inversely as the square of the distance between them.'

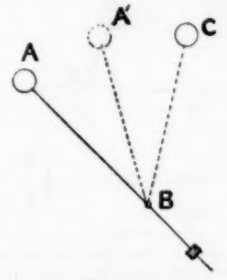


FIG. 4.

This can conveniently be proved by means of Coulomb's torsion balance. A small pith ball A is carried on the end of a piece of capillary glass tube counterweighted at the other end, and the whole is suspended by a fine metallic wire or quartz fibre at B. Another similar pith ball C is carried on a fixed glass rod. Let A and C be now similarly charged: they will repel each other, and in order to bring them to the same position as at first, the torsion head attached to the suspending wire must be turned through an angle θ, say. Now if A and C be at the same distance r from B, we have that the distance between them

$$= 2r \sin \frac{\angle ABC}{2} = 2r \sin \frac{\phi_1}{2}, \text{ if } \angle ABC = \phi_1.$$

Now twist the torsion head till A has approached more nearly to the position of C. Let ϕ_2 be the new angle A'BC. Then distance between A' and C $= 2r \sin \frac{\phi_2}{2}$.

Also the torsional force exerted by the twisted wire is proportional to the twist. This was, of course, θ_1 in the first instance, and $\theta_2 - (\phi_2 - \phi_1)$ in the second, if θ_2 be the total angle through which the torsion head has been turned from its primary position. Then it will be found that

$$\frac{\theta_1}{\theta_2 + \phi_1 - \phi_2} = \frac{\left(\sin \frac{\phi_2}{2}\right)^2}{\sin \left(\frac{\phi_1}{2}\right)^2},$$

i.e., that the force exerted between two small electrified bodies varies inversely as the square of their distance apart.

Voltaic Electricity.

'Define unit magnetic pole and unit electrical current in the electro-magnetic system, and state the relation of the ampère to the latter.'

The *unit magnetic pole* is of such a strength that when placed at unit distance from another similar pole, it repels it with unit force.

In the C.G.S. system the unit distance is of course 1 centimetre, and the unit force is 1 dyne, or 1 centimetre per second per second.

Also, *unit field* repels a unit pole placed in it with a force of 1 dyne.

Unit current, when flowing through a wire of unit length (1 cm.), bent into an arc of a circle of unit radius, produces a unit field at the centre of the circle.

The *ampère* is $\frac{1}{10}$ of the C.G.S. unit of current.

'Describe and explain a method of comparing the resistances of two coils of wire having given a battery, galvanometer, wire, and a foot rule.'

The resistances of the two coils of wire may be compared by extemporizing, with the materials prescribed, a Wheatstone's bridge, and then proceeding in the usual way.

The bridge may be extemporized as follows:—Stretch a piece of uncovered German silver wire on a bench between two nails A and B, and connect with copper wires the ends of this to R_1 and R_2, the two coils whose relative resistances are required, the other terminals of these latter being connected by means of a copper wire CD. Join a battery (such as a Leclanché cell) to A and B, and having joined one terminal of the galvanometer to CD, with a wire connected to the other touch along AB till a point is found where no deflection occurs in the galvanometer. Call this point E. Then Resistance of R_1 : Resistance of R_2 :: length AE : length EB. The latter lengths can be measured with the foot rule.

To prove this, let X be the potential of the cell used; then we have, since the potential falls uniformly along the resistance

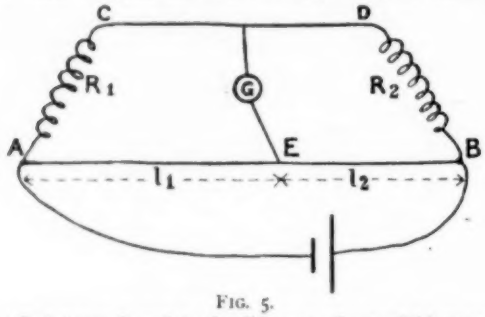


FIG. 5.

$R_1 + R_2$ between B and A, the difference of potential between B and the point where the galvanometer is joined to CD

$$= X\frac{R_2}{R_1 + R_2}.$$

Also, if ρ = resistance of unit length of the wire AB, and if $AE = l_1$, and $EB = l_2$, difference of potential between B and E

$$= X\frac{\rho l_2}{\rho(l_1 + l_2)} = X\frac{l_2}{l_1 + l_2}.$$

For there to be no current in the galvanometer, these two potentials must be equal.

$$\therefore X\frac{R_2}{R_1 + R_2} = X\frac{l_2}{l_1 + l_2};$$

$$\therefore \frac{R_1 + R_2}{R_2} = \frac{l_1 + l_2}{l_2}$$

$$\frac{R_1}{R_2} + 1 = \frac{l_1}{l_2} + 1;$$

$$\therefore \frac{R_1}{R_2} = \frac{l_1}{l_2}.$$

'A battery of 12 equal cells in series screwed up in a box, being suspected of having some of the cells wrongly connected, is put into circuit with a galvanometer and two cells similar to the others. Currents in the ratio of 3 to 2 are obtained according as the introduced cells are arranged so as to work with or against the battery. What is the state of the battery? Give reasons for your answer.'

Let E = the E.M.F. of each cell.
R = the Resistance ,, ,,
r = ,, ,, of the galvanometer.
x = the number of cells connected up wrongly, *i.e.*, so as to oppose the rest of the cells.

Then when the two cells are connected up so as to reinforce the battery of cells, the E.M.F. of the whole will be

$$\{(12 - x) - x + 2\}E = (14 - 2x)E.$$

The resistance will be $14 \times R + r$;

$$\therefore \text{Current} = \frac{\text{E.M.F.}}{\text{Resistance}} = \frac{(14 - 2x)E}{14R + r}.$$

Similarly when the two cells are connected up so as to oppose the battery, the E.M.F. will be $\{12 - 2x - 2\}E = 10 - 2x$.

$$\text{Current} = \frac{(10 - 2x)E}{14R + r}.$$

But the currents in these two cases are as 3 to 2;

$$\therefore \frac{(14 - 2x)E}{14R + r} : \frac{(10 - 2x)E}{14R + r} :: 3 : 2;$$

$$\text{or } \frac{14 - 2x}{10 - 2x} = \frac{3}{2},$$

$$28 - 4x = 30 - 6x,$$

$$2x = 2; \therefore x = 1.$$

Therefore there is one battery connected up wrongly.

'Describe a machine which is set in rotation by passing an electric current through some of its movable parts. What is the effect on the current if while it is still flowing the movement of the machine is stopped?'

An electro-motor is a machine which is set in rotation by passing a current through its movable part, called the armature. In its simplest form it consists of a single turn of wire ABCD supported in such a manner that it can rotate about an axis EF, between two magnetic poles S and N. Now suppose that an electric current is sent round the armature in the direction ABCD; then by Ampère's law, since the lines of force pass from S to N, AB will tend to move upward out of the plane of the paper. Similarly, CD will tend to move downward, so that a rotation of the armature is commenced. When AB has reached its highest point, which would be a point of

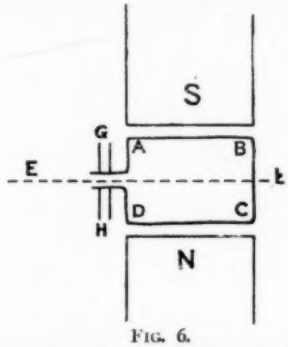


FIG. 6.

equilibrium, the inertia of the armature carries it onward, and the current is reversed by means of the brushes G and H passing on to opposite segments of a commutator provided for that purpose.

When the armature is rotating in the magnetic field, by Lenz's law an E.M.F. is generated in such a direction as to tend to stop its motion, *i.e.*, to oppose the current which produces its motion. On stopping the motion of the armature, this back E.M.F. is, of course, removed, so that the current increases.

'How may the strength of an electric current be measured by means of a copper voltameter?'

When an electric current is passed through a solution of copper sulphate between two plates of copper, the metal is dissolved from the plate at which the current goes in, and is deposited on the plate from which the current leaves the cell. The amount deposited in 1 second on this latter plate (called the kathode) has been found experimentally to be proportional to the current, provided the latter does not exceed a certain value dependent on the size of the kathode. The exact amount of copper deposited per second for one ampère of current has been carefully determined. Its value is ·000329 grms.

In performing the experiment, the anode plate (*i.e.*, that at which the current enters the voltameter) should be bent into a U, and the kathode plate suspended within it, the whole being placed in a solution of copper sulphate with a drop of sulphuric acid added. The kathode should be carefully cleaned with sand-paper, and weighed before the deposition begins, which should last from ½ to 1 hour. Of course only the *average* current during this time is determined by this method. At the end of the time the kathode plate is taken out of the copper sulphate solution, washed in warm water, and finally allowed to stand for some hours (if possible) in distilled water. It is then washed first in alcohol, then in ether, and dried over a spirit lamp. Let w = the increase of weight due to deposited copper. Then the average current passing during the time $= \frac{w}{\cdot 000329 \times t}$, where t = time (in seconds) during which deposition has lasted.

NOTES ON THEORETICAL MECHANICS.

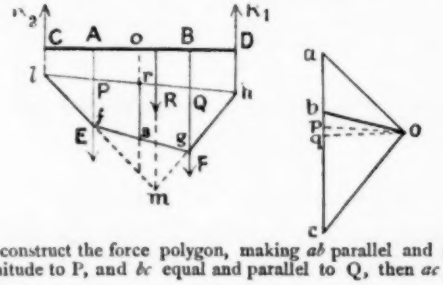
ADVANCED AND HONOURS STAGES.

BY F. CASTLE, M.I.M.E.

(*Continued from p.* 670, *vol.* XV.)

In the case of parallel forces—

Let P and Q be two parallel forces acting on a rigid body in similar directions, AE and BF, to find the resultant R.



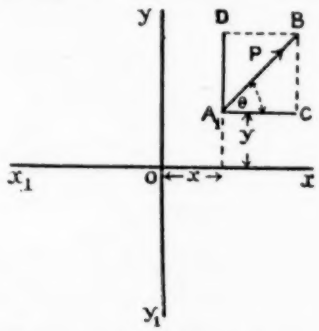
First construct the force polygon, making *ab* parallel and equal in magnitude to P, and *bc* equal and parallel to Q, then *ac* gives

the magnitude and direction of the resultant R; to find its point of application, assume any arbitrary point o, and join oa, ob, oc; next construct the funicular polygon fgm, where f is any convenient point, and fm, fg, gm are parallel to oa, ob, oc respectively, the point of intersection m is the point required.

If the two forces P and Q be supposed to act at points A and B on a rigid rod CD, the rod being supported at C and D; also if R_1 and R_2 denote the pressures at D and C respectively, R_1 and R_2 can be found as follows: produce mg to meet R_1 at h, and mf to meet R_2 at l; join l to h and draw op parallel to lh, then $cp = R_1$ and $pa = R_2$; also if oq be drawn perpendicular to ac to meet ac at q, then at any point o the algebraical sum of the moments of the forces acting on the rod on one side of o is given by the intercept rs on the funicular polygon, multiplied by oq.

Ex.—Given CD a rod 12 ft. long supported horizontally on two points CD, and carrying at A 120 lbs., and at B 240 lbs., the distances CA = BD = 3 ft., find the algebraical sum of the moments of the forces acting on the rod CD on one side of o, where o is the middle point of CD. Ans. 540.

Note.—Make the length CD to any convenient scale equal to 12 ft., and oq on the same scale equal to 5 or 10 ft. To any scale make $ab = 120$ and $bc = 240$ units, the intercept rs being measured on the same scale as ab and bc.



The resultant of any number of forces acting on a rigid body in one plane may be found by referring to two rectangular axes ox and oy. Thus let P be any given force acting at A; in the line AB draw AC and AD parallel to ox and oy respectively; if θ denote the angle BAC, then $AC = P\cos\theta$; this is denoted by X. $BC = P\sin\theta = Y = AD$. Also let the co-ordinates of point A be xy, then the force P at A is equivalent to the two forces X and Y acting at o, together with a couple xY in the positive direction and a couple yX in a negative direction, the algebraic sum being $x\mathrm{Y} - y\mathrm{X}$, and a similar result would be obtained for any number of forces. In making the sum it is necessary to bear in mind that all components above the line xox, and to the right of yoy, are positive; all below xox, and to left of yoy, negative.

Denoting the algebraic sums by ΣX and ΣY, the resultant $R = \sqrt{(\Sigma X)^2 + (\Sigma Y)^2}$

The direction is given by $\tan\phi = \dfrac{\Sigma Y}{\Sigma X}$.

The resultant couple by $\Sigma(x\mathrm{Y} - y\mathrm{X})$.

If the given forces are in equilibrium, then

$$R = o \text{ and } \Sigma(x\mathrm{Y} - y\mathrm{X}) = o.$$

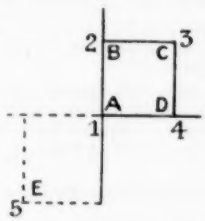
Questions—Advanced Stage.—(1) A rod is supported horizontally on two points A and B, 12 ft. apart; and is loaded by the following vertical loads—5 lbs., 8 lbs., 6 lbs., 11 lbs., and 6 lbs., at distances 1, 3, 5, 8 and 10½ feet respectively from the support A; find the pressures on the points of support. If it were necessary to balance the bar on a single support, find the position of that support and the pressure on it.

Ans. Pressures at A = 18½ lbs., at B 17½ lbs., 5·83 ft. from A, and 36 lbs.

(2) Draw a square ABCD; suppose forces of P and Q units to act from A to B, and from A to D respectively; find the perpendicular distance of the line of action of their resultant from C. (1888.)

Ans. $\dfrac{Q - P}{\sqrt{Q^2 + P^2}} \times a$ where a = side of square.

(3) ABCD is a square, the sides AB and AD being taken as axes of co-ordinates; masses of 1, 2, 3, 4 units are placed at A, B, C, D respectively; find the co-ordinates of the point where a mass of 5 units must be placed that the centre of gravity of the whole may be at A. (1888.)



Solution.—Let a = side of square.

$$\Sigma x = 4a + 3a = 7a.$$
$$\Sigma y = 3a + 2a = 5a.$$

Let x and y denote the co-ordinate of the mass 5 units.

$\Sigma x = 7a + 5x$, for equilibrium this sum must be zero; also $\Sigma y = 5a + 5y = 0$.

$$\therefore\ x = -\frac{7}{5}a\ ;\ y = -a.$$

(4) Draw a square, whose angular points in order are A, B, C, D, and suppose equal forces (P) to act from D to A, A to B, and B to C respectively, and a fourth force 2P to act from C to D; find a point, such, that if the moments of the forces are taken with respect to it, the algebraical sum is zero. (1890.)

Ans. Produce BC to F, making CF = 2BC, through F draw a line parallel to CD, then any point on the line CF is the point required.

5. Assuming the construction called the 'triangle of forces,' show that if three forces are in equilibrium at a point, each is proportional to the sine of the angle between the directions of the other two.

Draw a triangle ABC with its base AB horizontal, and its vertex C downwards; let AC and BC represent threads fastened to fixed points at A and B, and at C to a third thread which carries a given weight W; given the angles of the triangle ABC, find the tensions of the threads. (1890.)

Ans. Tension in $\mathrm{CA} = \mathrm{W}\dfrac{\cos\mathrm{B}}{\sin\mathrm{C}}$.

$$\text{Tension in CB} = \frac{\mathrm{W}\cos\mathrm{A}}{\sin\mathrm{C}}.$$

6. ABCD is a square, and AC a diagonal; forces P, Q, R act along parallel lines at B, C, D respectively, Q acts in the direction A to C, P and R act in the opposite direction; find, and show in a diagram, the position of the centre when Q = 5P and R = 7P. (1889.)

Ans. Join B to D and produce to a point F, making DF = ¼BD, then F is the centre required.

SOLUTIONS TO QUESTIONS IN THEORETICAL MECHANICS, MAY, 1895.

SOLIDS—ELEMENTARY STAGE.

BY F. CASTLE, M.I.M.E.

1. (*a*) Name a unit of distance, a unit of time, and a unit of mass. If velocity is given in miles an hour, how can it be found in feet a second?

(*b*) If a velocity is 7½ miles an hour, what is it in feet a second? (10.)

(*a*) The units in common use are the foot, the second, and the pound respectively, and known as the British system.

The corresponding units in the C.G.S. system are the centimetre, the second, and the gramme.

1 mile = 5,280, and 1 hour = 3,600 seconds; hence multiply the number of miles by 5,280 and divide by 3,600.

(*b*) $\dfrac{7\frac{1}{2} \times 5280}{3600} = 11$ ft. per sec.

2. (*a*) State how to find the resultant of any number of forces acting along a line.

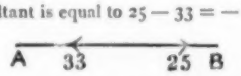
(*b*) State what is meant by the 'algebraical sum' of two numbers, and give an example.

(*c*) Draw a straight line AB, and let three forces of 15, 10, and 33 units respectively act along it; the former two act from A to B, the last acts from B to A; find their resultant. (10.)

(*a*) The magnitude of the resultant is the algebraical sum of the components; the direction is determined by a positive or negative sign of the sum.

(*b*) When the algebraical signs indicating positive and negative directions are applied to numbers, and those of like signs are added together, the difference between these two numbers with the sign of the greater prefixed, is called the algebraical sum.

(*c*) The resultant is equal to $25 - 33 = -8$.



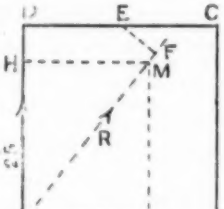
3. (*a*) Define the moment of a force with respect to a point.

(*b*) State the relation that holds good between the moments of two forces, and the moment of their resultant; all the moments being taken with respect to a point in the plane of the forces.

(*c*) A, B, C, D are the angular points of a square taken in order, a force of 20 units acts from A to B, and a force of 25 units from A to D; by means of the rule you have enunciated, find the moment of the resultant about the middle point of DC, a side of the square being 6 units long. (12.)

(*a*) The moment of a force with respect to a given point is the product of the force and the perpendicular from the given point upon the line of action of that force.

(*b*) The algebraical sum of the moments of the two given forces about the point is equal to the moment of their resultant about the same point.



(*c*) Let E be the middle point of DC,

Moment of force along AB about E $= 6 \times 20$.

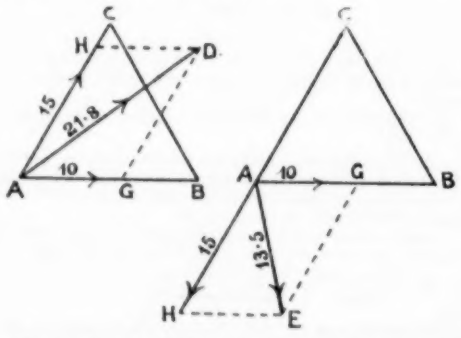
Moment of force along AD about E $= -3 \times 25$.

Algebraical sum $= 6 \times 20 - 3 \times 25$

$= 45$.

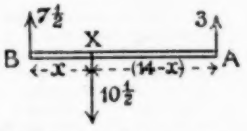
This may be verified by making AG = 20; AH = 25; the resultant AM (either by calculation or measurement) is found to be 32. Also EF, a line drawn perpendicular to AM and meeting AM in F, is 1·44 in length, hence moment of resultant R about E $= 32 \times 1{\cdot}44 = 45$.

4. Draw an equilateral triangle ABC; a force of 10 units acts from A to B, and one of 15 units from A to C; find their resultant by construction. Also find what their resultant would be if the force of 15 units acted from C to A.



The resultant in the first case will be found to equal 21·8 units; this is shown in the diagram, where AG = 10, AH = 15, AD = 21·8. In the second case the resultant AE = 13·2 units.

5. A weightless rod AB rests horizontally on two points under A and B 14 ft. apart; it carries a weight suspended from a point X, which causes a pressure of 3 units on A, and of $7\frac{1}{2}$ units on B; find the distance of X from A. (10.)



The weight at X is equal to $7\frac{1}{2} + 3 = 10\frac{1}{2}$.

Let the distance of point X from B be denoted by x, then AX $= (14 - x)$.

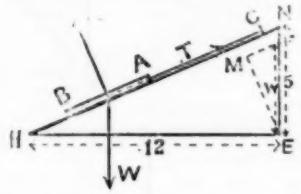
Taking moments about B we have $3 \times 14 = 10\frac{1}{2} \times x$;

$$\therefore x = \frac{42}{10\frac{1}{2}} = 4.$$

Hence the distances AX and BX are 10 and 4 respectively.

6. (*a*) A rod AB is placed on a smooth inclined plane, and the end A is tied by a string AC to a fixed point C on the plane; show how to find the pressure on the plane, and the tension of the string.

(*b*) If the length of the base of the plane is 12 ft., and the height of the incline is 5 ft., and if the rod weighs 10 lbs., find the numerical values of the pressure and the tension.



(*a*) The length of the plane is $\sqrt{5^2 + 12^2} = 13$. At G, the centre of gravity of the rod, three forces are acting; these are T the tension of the string, R the pressure on the plane, and the weight W.

If EF be drawn parallel and equal in magnitude to W, FM be drawn parallel to the string AC, and EM perpendicular to NH or parallel to R (where R denotes the reaction of the plane), then FM will give the tension T of the string and EM the reaction of the plane.

(*b*) From the similar triangles EFM and NEH we have

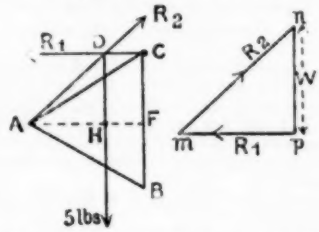
$$\frac{T}{W} = \frac{5}{13}; \qquad \therefore T = 10 \times \frac{5}{13} = \underline{3{\cdot}83 \text{ lbs.}}$$

$$\frac{R}{W} = \frac{12}{13}; \qquad \therefore R = 10 \times \frac{12}{13} = \underline{9{\cdot}23 \text{ lbs.}}$$

7. (*a*) Mention the four points that go to the complete specification of a force.

(*b*) Draw an equilateral triangle ABC, with the side BC vertical, and C above B; let it represent a triangular board weighing 5 lbs., capable of moving in a vertical plane round a hinge at A, but kept in position by leaning against a fixed point which touches BC at C; find the reaction of the fixed point, and of the hinge.

(*c*) Specify completely the reaction of the hinge. (16.)



(*a*) (1) The point at which it acts; (2) the line along which it acts; (3) the direction along the line; (4) the magnitude.

(*b*) The weight of the board will act through the centre of gravity H, where FH $= \frac{1}{3}$ FA.

The three forces keeping the board in equilibrium are R_1 the reaction at C, R_2 the reaction of the hinge A, and the weight W. Since R_1 is horizontal and W vertical, and these intersect at point D, then A joined to D gives the direction of the reaction at A. To find the magnitude, on any scale make np =

W, draw pm and mn parallel to R_1 and R_2 respectively, intersecting at m, then $pm = R_1 = 5{\cdot}8$ lbs., and $mn = R_2 = 7{\cdot}6$ lbs.

By calculation, taking moments with respect to A,

$$R_1 \times \frac{a}{2} = W \times AH = \frac{5 \times a\sqrt{3}}{3}. \quad (a = \text{side of triangle.})$$

$$\therefore R_1 = \frac{10\sqrt{3}}{3} = \underline{5{\cdot}8}.$$

And in similar manner (by taking moments with respect to C) $R_2 = 7{\cdot}6$.

(*c*) (1) The reaction acts at A.
(2) Is along the line AD.
(3) The direction from A to D.
(4) The magnitude is $7\frac{1}{2}$ lbs.

8. (*a*) Define 'Power' and Horse-Power.'

(*b*) An engine with its tender weighs 80 tons; it is moving uniformly at the rate of 20 miles an hour against a resistance of 7 lbs. a ton; at what horse-power is it working?

(*c*) If it drew after it a train of 12 carriages, each weighing 10 tons, at the rate of 40 miles an hour, against a resistance of 8 lbs. a ton, at what horse-power would it now be working? (14.)

(*a*) 'Power' is the rate of doing work. A power which can do 33,000 foot pounds of work per minute is called one-horse power (usually denoted by the symbol H.P.).

(*b*) The rate is $\frac{1}{3}$ of a mile or 1,760 feet per minute. The resistances are 80×7 lbs.

$\therefore$ Work done per minute $= 80 \times 7 \times 1{,}760$.

$$\therefore \text{H.P.} = \frac{80 \times 7 \times 1{,}760}{33{,}000}$$

$$= \underline{29{\cdot}87}.$$

(*c*) The rate is $\frac{2}{3}$ of a mile, or 3,520 feet per minute.
The resistances $(80 + 12 \times 10)$ 8 lbs. $= 200 \times 8$ lbs.
Work done per minute $= 200 \times 8 \times 3{,}520$;

$$\therefore \text{H.P.} = \frac{200 \times 8 \times 3{,}520}{33{,}000}$$

$$= \underline{170\tfrac{2}{3}}.$$

9. (*a*) Define a poundal (or British absolute unit of force).

(*b*) If a force of 5 poundals acts on a mass of 10 lbs. in the direction of the motion, what velocity would it impart to the mass in 3 seconds? (12.)

(*a*) The poundal is that force which, acting on a mass of one pound for one second, gives it a velocity of one foot per second.

(*b*) acceleration $= \frac{\text{Force}}{\text{Mass}} = \frac{5}{10} = \frac{1}{2}$

velocity in 3 secs. $= 3 \times \frac{1}{2}$
$= \underline{\frac{3}{2} \text{ ft. per second.}}$

10. (*a*) A body is thrown upward from the top of a tower with a velocity of 48 ft. a second; find where it will be at the end of 4 seconds. ($g = 32$.)

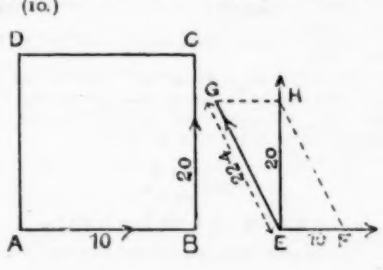
(*b*) Write down the formula or formulæ by means of which you answer this question, and state what it means (or they mean). (14.)

$$S = Vt - \tfrac{1}{2}gt^2$$
$$= 48 \times 4 - \tfrac{1}{2} \times 32 \times 16$$
$$= 192 - 256$$
$$= -64 \text{ ft.}$$

The negative sign indicating that the body is 64 feet below the point of projection.

(*b*) In the formula, S is the distance of the moving body from its starting point at the end of time t, also V is the initial velocity of the body.

11. Draw a square ABCD; a particle moves along AB with a velocity 10; it is made to move along BC with a velocity 20. Find the magnitude and direction of the velocity that must be impressed on it at B. (10.)



Draw the square ABCD. Take any point E and draw EF parallel to AB and equal to 10, EH parallel to BC and equal to 20; join H to F, and make EG parallel to FH, and HG parallel to EF; then EG gives the magnitude and direction of the velocity required; EG is found to be 22·4 units.

12. (*a*) A body moves with a constant velocity in a given circle; state what is known as to the force which acts on the body.

(*b*) Find a numerical result when a mass of the body is 10 lbs., and it moves at the rate of 900 ft. a minute in a circle 3 yards in diameter. (16.)

(*a*) If a particle describe a circle of radius r with a constant velocity v, the acceleration f is in magnitude equal to $\frac{v^2}{r}$ and in direction towards the centre of the circle. If P denote the force required to produce in a mass m an acceleration f, then $P = mf = \frac{mv^2}{r}$.

(*b*) In the example $v = \frac{900}{60} = 15$ ft. per sec. $r = 9$ ft.

$$\therefore P = \frac{10 \times 15 \times 15}{9} = \underline{250 \text{ poundals.}}$$

SCIENCE NOTES.

TELEPHONIC DEVELOPMENT.—The telegraph seems to be within measurable distance of being left behind by its younger competitor the telephone, at least as far as inland purposes are concerned. Recently we saw inaugurated the completion of telephonic communication with Scotland and Ireland. The wires to Ireland extend from London, through Leeds and Carlisle, to Portpatrick; thence by cable across St. Patrick's Channel to Donaghadee and on to Belfast and Dublin, the distance from London to Dublin being 467 miles. The wires to Scotland branch off at Carlisle and go to Glasgow, and thence to Edinburgh. The formal opening took place on the 12th of June, in the presence of a distinguished company, which included the Postmaster-General, the Lord Mayor, Lord Kelvin (President of the Royal Society), Sir John Gorst, Lord Balfour of Burleigh, and most of the members of the Select Committee of the House of Commons on Telephonic Communication. The Postmaster-General first spoke with the Lord Provost of Edinburgh, and then the Lord Mayor carried on a short conversation with the Lord Provosts of Edinburgh and Glasgow and the Lord Mayors of Dublin and Belfast. The President of the Royal Society then had a chat with some scientific friends in Glasgow. Both the Lord Mayor and Mr. Arnold Morley were enabled next to speak to friends at Nottingham. Another circuit, 1,270 miles in length, has been established between Plymouth and Dublin. We seem on the eve of linking thus together all the important centres of Great Britain and Ireland, and forming a complete network of telephonic communication.

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THE DELETERIOUS GASES OF COAL MINES.—Considerable attention has been devoted of late to the constituents of the various accumulations of gases which form one of the chief dangers of the coal mine. These seem to be not two, as generally met with—viz. *fire-damp*, or carburetted hydrogen, and *after-damp*, or *choke-damp*, otherwise carbonic acid—but a third is often present, now technically known as *black-damp*. This latter gas, or rather mixture of gases, consists of nitrogen, containing an admixture of about 12 or 14 per cent. of carbonic acid or carbon dioxide. Its dangerous characteristic is that it acts as a poison when inhaled, its physiological action being due to the deficiency of oxygen, even when it is considerably diluted with air. When a proportion of black-damp which will extinguish a candle or oil-lamp is present in the air, the latter is still free from immediate danger to human life.

***

THE NEW ELEMENTS.—The scientific world continues in an agitated state through the investigations and discoveries of helium and argon, and more and more interesting facts are expected. Professor Lockyer has been engaged in testing other minerals than clèvite for helium, including broggerite, pitchblende, samarkite, and meteoric iron. He concludes that helium is not a single new element, but a highly complex aggregation of rare gases. A most suggestive fact about it is that it is found in minerals which are probably typical of the matter of the earth's substance in regions far down towards the interior of the globe. Another point of almost equal interest is that many of the lines found in the spectra of various samples of helium have been identified with lines occurring in many of the stars.

LADIES' NIGHT AT THE ROYAL SOCIETY.—Though the soirée of the Royal Society which is held in the early part of May is generally the event of the year as regards demonstrations of scientific discovery, yet the ladies' night held a month or so later is often the occasion of very important communications. A striking feature this year was that the Edinburgh, Glasgow, and Dublin telephone was by the kindness of the Postmaster-General connected up to Burlington House for the occasion. As a result, conversations with Scotland and Ireland were kept up briskly during the whole of the evening. There were but few new features. Sir David Salomons showed an intensely powerful electro-magnet at work—so powerful as to injure the watches of any approaching visitors, who were therefore cautioned not to go within a yard of its poles. The magnet was shown to twist the glowing filament of an incandescent lamp about with great violence.

***

FLUORIDES AS ANTISEPTICS.—The compounds of fluorine are making their way into very extensive use for the preservation of food and as antiseptic medicines. Their progress seems only to be checked by the fears entertained of their poisonous nature. Experiments made with animals, however, show that they can take immense quantities of these salts with perfect impunity, and even after continued use no poisonous effects result. Tappeiner has recently experimented on the quantity of sodium fluoride which would be toxic for an animal of one thousand pounds weight, and finds that it would have to swallow at least one thousand litres of beer refuse per day before evil results would follow. The lethal dose would be half a kilogram to each kilogram of body weight, an impossible quantity. Goats and dogs have been given daily for three months from 0·3 to 0·5 gramme of sodium fluoride with their food without being any the worse for their experience. In the case of the goats the salt given did not even affect the milk. There is, however, a certain difference in its effect on the human organism which is somewhat serious. Bloxam consumed a piece of salmon which had been lying for three months in a five per cent. solution of sodium fluoride. After eating, salivation at once set in, and sickness and diarrhœa followed, while later the circulation became very feeble and slow. The quantity of sodium fluoride consumed he estimated to have amounted to about 5·5 grammes.

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THE LONDON CATALOGUE OF BRITISH PLANTS.—For a long time past a new edition of this valuable work has been an urgent need, and now that the Index Kewensis has appeared, it has become possible to issue one which will be likely to serve for many a year. Botanists will, therefore, welcome heartily its recent appearance, especially as it has been edited by Mr. Frederick Hanbury, the well-known specialist on the genus *Hieracium*. Mr. Hanbury has had for collaborators Mr. Daydon Jackson, the compiler of the Index Kewensis, Mr. Britten of the British Museum, Mr. Arthur Bennett, and other well-known botanists. Comparing the present with the last edition, it is gratifying to observe that but few alterations have been made in the list of genera.

***

PROTECTION TO SHIPS' BOTTOMS.—Many methods have been devised and tried to keep the hull of a ship free from barnacles without very great success. The importance of so doing becomes obvious when we consider the extra amount of coal needed to propel a large vessel whose bottom is covered by these creatures, upwards of twelve tons of them having in some cases accumulated. A new device has recently been patented by an American discoverer, which consists in applying a process of electroplating to the hull, a thin film of copper being laid down upon the iron. The barnacles will not remain upon copper. The latter is applied by attaching to part of the hull a temporary tray or bath, in which the necessary solutions are held in contact with the iron surface. First is applied an acid solution to clean the surface, and afterwards a copper solution. By means of an electric current the latter is made to deposit metallic copper in a thin film upon the iron.

***

A NEW DANGER IN SUBMARINE TELEGRAPHY.—The dangers to which submarine cables are exposed have been lately ascertained to be increased by attacks made upon them by minute marine organisms. One of these, known as the *gribble*, has developed a liking for the gutta-percha which is used to insulate the wires, and it has acquired the habit of boring into the cable behind the sheathing of strong iron wire. The result has been to destroy the insulating material and to expose the copper strands, when the water at once penetrates, and the conducting power of the cable is gone. To remedy it a sheathing of brass is wound round the insulated bundle of wires in the form of a thin metal tape.

MATHEMATICS.

STAGES 2 AND 3, SCIENCE AND ART DEPARTMENT.

BY G. A. BAXANDALL,
Assistant Mathematical Instructor, Royal College of Science, London.

SOLUTIONS TO THE SECOND STAGE PAPER OF THE SCIENCE AND ART EXAMINATION, MAY 1895—(*Cont.*).

33. (*a*) Find the logarithm (with a positive mantissa) of $(0{\cdot}00112)^{\frac{1}{4}}$ and of $(\sin 18^\circ\ 37')^{-\frac{1}{2}}$.

(*b*) Find the numerical value of $\frac{1}{(1{\cdot}44)^3}$. (25).

(*a*) $\because \log (0{\cdot}00112)^{\frac{1}{4}} = \frac{1}{4}\log 0{\cdot}00112 = \frac{1}{4}\log \frac{112}{100000}$
$= \frac{1}{4}[\log 112 - 5] = \frac{1}{4}[\log (7\times 2^4) - 5]$
$= \frac{1}{4}[\log 7 + 4\log 2 - 5] = \frac{1}{4}[3{\cdot}0492180]^*$
$= \underline{\bar{1}{\cdot}2623045}.$

$\log (\sin 18^\circ\ 37')^{-\frac{1}{2}} = -\frac{1}{2}\log \sin 18^\circ\ 37'$
$= -\frac{1}{2}(\text{L sin } 18^\circ\ 37' - 10)$
$= 5 - 4{\cdot}7520552^* = \underline{{\cdot}2479447}.$

(*b*) Let $x = \frac{1}{(1{\cdot}44)^3}$,

$\log x = \log 1 - \log (1{\cdot}44)^3 = -3\log \frac{144}{100}$
$= -3(\log 144 - 2) = 6 - 3(\log 3^2.2^4)$
$= 6 - 6{\cdot}4750878^* = -{\cdot}4750878 = \bar{1}{\cdot}5249122.$

* $\log {\cdot}33490 = \bar{1}{\cdot}5249151$ $\quad$ $\log x = \bar{1}{\cdot}5249122$
$\log {\cdot}33489 = \bar{1}{\cdot}5249022$ $\quad$ $\log {\cdot}33489 = \bar{1}{\cdot}5249022$
${\cdot}00001$ $\quad$ ${\cdot}0000129$ $\quad$ y $\quad$ ${\cdot}0000100$

then $\frac{y}{{\cdot}00001} = \frac{100}{129}$; $\therefore y = \frac{100}{129}\times {\cdot}00001 = {\cdot}0000078.$

$\therefore x = {\cdot}33489 + {\cdot}0000078 = \underline{{\cdot}3348878}.$

34. (*a*) Show how to construct an angle whose sine is $\frac{1}{3}$, and find the value of the cosine, the tangent, and the secant of that angle.

(*b*) Find all the positive values of θ, less than four right angles, which satisfy the equation $2\sin 3\theta = 1$. (20)

(*a*) Draw an indefinite line AB; at A erect a perpendicular, AC, of unit length. With C as centre, and 3 units as radius, describe an arc cutting AB in D, then the angle CDA is the angle required, for its sine is $\frac{1}{3}$. $AD = \sqrt{8} = 2\sqrt{2}$, therefore

$\cos \text{CDA} = \frac{2\sqrt{2}}{3}$, $\tan \text{CDA} = \frac{1}{2\sqrt{2}} = \frac{\sqrt{2}}{4}$, $\sec \text{CDA} = \frac{3}{2\sqrt{2}} = \frac{3\sqrt{2}}{4}$.

(*b*) $2\sin 3\theta = 1$; $\therefore \sin 3\theta = \frac{1}{2}$; $\therefore 3\theta = 30^\circ, 150^\circ, 390^\circ, 510^\circ, 750^\circ, 870^\circ$; $\therefore \theta = 10^\circ, 50^\circ, 130^\circ, 170^\circ, 250^\circ$, or 290°, all of which are positive and less than 360°.

35. (*a*) Show that in any triangle the sides are proportional to the sines of the opposite angles, when the angles are acute, and when one of them is obtuse.

(*b*) Find all the parts of the triangles, which have one side 90 feet long, another side 60 feet long, and the angle opposite to the shorter side equal to $18^\circ\ 37'$. (25)

(*a*) The proof for this is found in every text-book of Trigonometry.

(*b*) $\text{Sin C} = \frac{c}{b}\sin \text{B} = \frac{90}{60}\sin \text{B} = \frac{3}{2}\sin \text{B}.$

$\therefore \text{L sin C} - 10 = \log 3 + \text{L sin B} - 10 - \log 2.$
$\text{L sin C} = 9{\cdot}6802018^*.$

$\text{L sin } 28^\circ\ 37' = 9{\cdot}6802877^*$ $\quad$ $\text{L sin C} = 9{\cdot}6802018$
$\text{L sin } 28^\circ\ 36' = 9{\cdot}6800560$ $\quad$ $\text{L sin } 28^\circ\ 36' = 9{\cdot}6800560$
$60''$ $\quad$ ${\cdot}0002317$ $\quad$ x'' $\quad$ ${\cdot}0001458$

$\frac{x}{60} = \frac{1458}{2317}$; $\therefore x = 37''{\cdot}7$, and $\text{C} = 28^\circ\ 36'\ 37''{\cdot}7$.

$\therefore \text{A} = 180 - [18^\circ\ 37' + 28^\circ\ 36'\ 37''{\cdot}7] = 136^\circ\ 46'\ 22''{\cdot}3.$

This is the ambiguous case, and considering the smaller triangle ABC', $\text{C}' = 180 - 28^\circ\ 36'\ 37''{\cdot}7 = 151^\circ\ 23'\ 23''{\cdot}3$, and therefore A' or $\text{BAC}' = 9^\circ\ 59'\ 37''{\cdot}7$.

To get BC.

$$a = c\frac{\sin \text{A}}{\sin \text{C}'}$$

$$\log a = \log c + \text{L sin A} - \text{L sin C}.$$

* The asterisk denotes that the tables have been used.

Now $\sin A = \sin 47^\circ\ 13'\ 37''{\cdot}7$.

L $\sin 47^\circ\ 14' = 9{\cdot}8657700$*

,, $\underline{47^\circ\ 13' = 9{\cdot}8656531}$

$60''$ $\cdot0001169$.

$\therefore$ L $\sin A = 9{\cdot}8656531 + \frac{37{\cdot}7}{60}$ of $\cdot0001169$

$= 9{\cdot}8657266$;

$\therefore \log a = \log 90 + 9{\cdot}8657266 - 9{\cdot}6802018 = 2{\cdot}1397674$

$\log 137{\cdot}97 = 2{\cdot}1397847$*		$\log a = 2{\cdot}1397674$	
,, $\underline{{\cdot}96 = 2{\cdot}1397532}$		$\log \underline{137{\cdot}96 = 2{\cdot}1397532}$	
$\cdot01$	$\cdot0000315$	x	$\cdot0000142$

$\frac{x}{\cdot01} = \frac{142}{315}$; $\therefore x = \frac{142}{315} \times \cdot01 = \cdot0045$;

$\therefore a = 137{\cdot}96 + \cdot0045 = \underline{137{\cdot}9645}$.

To get BC′ or a′.

$$\frac{a'}{b} = \frac{\sin 9^\circ\ 59'\ 37''{\cdot}7}{\sin 18^\circ\ 37'},$$

$\log a' = \log 60 + $ L $\sin 9^\circ\ 59'\ 37''{\cdot}7 -$ L $\sin 18^\circ\ 37'$.

Now L $\sin 10^\circ\ 0' = 9{\cdot}2396702$*

,, $\underline{9^\circ\ 59' = 9{\cdot}2389532}$

$60''$ $\cdot0007170$

$\therefore$ L $\sin 9^\circ\ 59'\ 37''{\cdot}7 = 9{\cdot}2389532 + \frac{37{\cdot}7}{60} \times \cdot0007170$

$= 9{\cdot}2394037$.

$\therefore \log a' = \log 60 + 9{\cdot}2394037 - 9{\cdot}5041105 = 1{\cdot}5134445$,

$\log 32{\cdot}618 = 1{\cdot}5134573$*		$\log a = 1{\cdot}5134445$	
,, $\underline{32{\cdot}617 = 1{\cdot}5134440}$		$\log \underline{32{\cdot}617 = 1{\cdot}5134440}$	
$\cdot001$	$\cdot0000133$	x	$\cdot0000005$

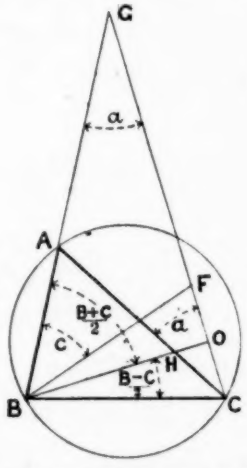
$x = \frac{5}{133} \times \cdot001 = \cdot0000376$;

$\therefore a' = 32{\cdot}617 + \cdot0000376 = \underline{32{\cdot}6170376}$.

36. (*a*) In any triangle ABC, show geometrically that

$(b + c) \tan \frac{1}{2}(B - C) = (b - c) \tan \frac{1}{2}(B + C)$.

(*b*) If $b = 400$ feet, $c = 100$ feet, $A = 64^\circ\ 20'$, find B and C. (25.)



(*a*) ABC is any triangle with a circle circumscribed about it. Make the angle ABF = angle C; bisect FBC, and draw CO perpendicular to this bisector, producing it to meet BA produced at G. Now $FBC = B - C$, and $OBC = \frac{B - C}{2}$. Also $ABO = B - \frac{B - C}{2} = \frac{B + C}{2}$. Let us prove that the triangles AGC, ABH are isosceles, then it will follow that $CH = b - c$ and $BG = b + c$. The angle $BGC = 90^\circ - \frac{B + C}{2}$, and $ACG = BCO - C = \left(90^\circ - \frac{B - C}{2}\right) - C = 90^\circ - \frac{B + C}{2}$, therefore the triangle AGC is isosceles. Again, the angle $AHB = OHC = 90^\circ - a$, and $ABH = 90^\circ - a$, therefore AHB = ABH. So that now CH and BG are respectively $b - c$ and $b + c$.

$$\frac{\tan \frac{B - C}{2}}{\tan \frac{B + C}{2}} = \frac{\frac{CO}{OB}}{\frac{OG}{OB}} = \frac{CO}{OG} = \frac{\frac{CO}{CH} \cdot CH}{\frac{OG}{BG} \cdot BG} = \frac{CH}{BG} = \frac{b - c}{b + c},$$

since $\frac{CO}{CH}$ and $\frac{OG}{BG}$ are the sines of equal angles.

$$\tan \frac{B - C}{2} = \frac{b - c}{b + c} \tan \frac{B + C}{2} = \frac{3}{5} \tan 57^\circ\ 50'.$$

L $\tan \frac{B - C}{2} - 10 = \log 3 - \log 5 +$ L $\tan 57^\circ\ 50' - 10$.

L $\tan \frac{B - C}{2} = 9{\cdot}9795549$*.

L $\tan 43^\circ\ 40' = 9{\cdot}9797797$*		L $\tan \frac{B - C}{2} = 9{\cdot}9795549$	
,, $\underline{43^\circ\ 39' = 9{\cdot}9795268}$		,, $\underline{43^\circ\ 39' = 9{\cdot}9795268}$	
$60''$	$\cdot0002529$	x''	$\cdot0000281$

$\frac{x''}{60''} = \frac{281}{2529}$, or $x = 6''{\cdot}7$;

$\therefore \frac{B - C}{2} = 43^\circ\ 39'\ 6''{\cdot}7$.

$\frac{B + C}{2} = 57^\circ\ 50'$;

$\therefore B = 101^\circ\ 29'\ 6''{\cdot}7$, $C = 14^\circ\ 10'\ 53''{\cdot}3$.

37. (*a*) In the triangle ABC, if M is the middle point of BC, show that—

$$4AM^2 = b^2 + c^2 + 2bc \cos A.$$

(*b*) If BC is 6 inches long, find the length of AM, when $\tan C = 5 \tan B = 9 \operatorname{cotan} B$. (25.)

From a figure $AM^2 = b^2 + \left(\frac{a}{2}\right)^2 - 2b \cdot \frac{a}{2} \cdot \cos C$;

also $AM^2 = c^2 + \left(\frac{a}{2}\right)^2 - 2c \frac{a}{2} \cos B$;

$\therefore 2AM^2 = b^2 + c^2 + \frac{a^2}{2} - a(b \cos C + c \cos B)$

$= b^2 + c^2 + \frac{a^2}{2} - a^2$;

$\therefore 4AM^2 = 2b^2 + 2c^2 - a^2 = b^2 + c^2 + b^2 + c^2 - a^2$

$= b^2 + c^2 + 2bc \cdot \frac{b^2 + c^2 - a^2}{2bc} = b^2 + c^2 + 2bc \cos A$.

Q.E.D.

(*b*) Since $\tan C = 5 \tan B$, it follows that BD = 5 DC, but BC is actually 6 inches, therefore BD = 5 inches, and DC = 1 inch.

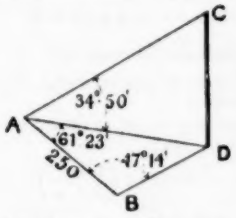
Again, $5 \tan B = \frac{9}{\tan B}$, therefore $5 \tan^2 B = 9$, and $\tan B = \pm \frac{3}{\sqrt{5}} = \frac{3\sqrt{5}}{5}$, therefore $AD = 3\sqrt{5}$. Hence

$b = \sqrt{(3\sqrt{5})^2 + 1} = \sqrt{46}$, and $c = \sqrt{(3\sqrt{5})^2 + 25} = \sqrt{70}$.

Now $4AM^2 = 2b^2 + 2c^2 - a^2 = 92 + 140 - 36 = 196$.

$AM^2 = 49$; $\therefore AM = \underline{7}$.

38. AB is a line 250 feet long, in the same horizontal plane as the foot, D, of a tower CD: the angles DAB and DBA are respectively 61° 23′ and 47° 14′, the angle of elevation CAD is 34° 50′; find the height of the tower. (25.)



The angle $ADB = 180^\circ - 61^\circ\ 23' - 47^\circ\ 14' = 71^\circ\ 23'$.

$\frac{AD}{AB} = \frac{\sin 47^\circ\ 14'}{\sin 71^\circ\ 23'}$;

$$\log AD = \log 250 + L\sin 47^\circ 14' - L\sin 71^\circ 23'$$
$$= 2{\cdot}2870503 \text{ on using the tables;}$$
$$\frac{CD}{AD} = \tan CAD = \tan 34^\circ 50';$$
$$\log CD = \log AD + L\tan 34^\circ 50' - 10$$
$$= 2{\cdot}1295854 \text{ on using the tables.}$$

Now log 134·77 = 2·1295932*		log CD = 2·1295854	
134·76 = 2·1295610		log 134·76 = 2·1295610	
·01	·0000322	x	·0000244

$$\frac{x}{0000244} = \frac{\cdot 01}{0000322} \text{ or } x = \frac{244}{322} \times \cdot 01 = \cdot 0075;$$
$$\therefore CD = 134{\cdot}76 + \cdot 0075 = \underline{134{\cdot}7675 \text{ feet.}}$$

41. Find the condition that the equations $x^2 + px + q = 0$ and $x^2 + p'x + q' = 0$ may have a common root.

Find c so that the equations $2x^2 + cx - 4 = 0$ and $12x^2 - 16x + 9c = 0$ may have a common root; find the value of this root. (30.)

Let a be the common root, then

$$a^2 + pa + q = 0; \quad (1)$$
$$a^2 + p'a + q' = 0;$$
$$\therefore a(p - p') = q' - q;$$
$$\therefore a = \frac{q' - q}{p - p'}$$

Substitute in (1) and simplify, getting

$$(q' - q)^2 + (p - p')(pq' - p'q) = 0, \quad (2)$$

which is the required condition for a common root.

If $2x^2 + cx - 4 = 0$, then $p = \frac{c}{2}$, $q = -2$.

If $12x^2 - 16x + 9c = 0$, then $p' = -\frac{4}{3}$, $q' = \frac{3}{4}c$.

Therefore, substituting in (2) we get, on simplifying, $c = -\frac{1}{3}$ as the condition for a common root. The quadratics now become $6x^2 - x - 12 = 0$ and $12x^2 - 16x - 3 = 0$, and since these have a common factor $2x - 3$, $x = \frac{3}{2}$ is the common root.

42. (*a*) Show that the geometrical mean of two positive quantities is greater than the harmonical mean.

(*b*) Let a, b, c be three positive quantities, and x, y, z the geometrical means between a and b, b and c, c and a respectively; if a, $a + x$, $a + y$ are in geometrical progression, show that x, y, and $-z$ are in harmonical progression. (30.)

(*a*) Let a and c be the two positive quantities. The G.M. $= \sqrt{ac}$ and the H.M. $= \frac{2ac}{a + c}$. The question arises, is $\sqrt{ac} > \frac{2ac}{a + c}$? This will be so if $(a + c)\sqrt{ac} > 2ac$, that is, if $a^2 + 2ac + c^2 > 4ac$, or if $a^2 - 2ac + c^2 > 0$, which is the case since $(a - c)^2$ *is* positive, for it is a perfect square.

(*b*) From the first statement we get $x = \sqrt{ab}$, $y = \sqrt{bc}$, $z = \sqrt{ac}$, and from the second statement $a(a + y) = (a + x)^2$, which becomes $ay = 2ax + x^2$. This, by using the three above equations, reduces to $a\sqrt{bc} = 2a\sqrt{ab} + ab$, or $\sqrt{c} - b = 2\sqrt{a}$, Now we are to show that x, y, and $-z$, are in H.P., that is, that $\frac{2x(-z)}{x - z} = y$. By using the first three equations, this equation becomes $\frac{-2\sqrt{a^2bc}}{\sqrt{ab} - \sqrt{ac}} = \sqrt{bc}$ which reduces to $-2\sqrt{a} = \sqrt{b} - \sqrt{c}$, which we know to be true.

43. Find by the Binomial Theorem :—

(*a*) The first five terms of the expansion of $(1 + x + x^2 + x^3)^n$, in ascending powers of x.

(*b*) The coefficient of $a^p\, b^q\, c^r$ in the expansion of $(a + b + c)^n$, where $p + q + r = n$. (35.)

$$(a)\ (1 + x + x^2 + x^3)^n = \left(\frac{1 - x^4}{1 - x}\right)^n = (1 - x^4)^n (1 - x)^{-n}$$
$$= \left[1 - nx^4 + \frac{n(n-1)}{1.2}x^8 + \ldots\ldots\right]\left[1 + nx + \frac{n(n+1)}{1.2}x^2 + \frac{n(n+1)(n+2)}{1.2.3}x^3 + \frac{n(n+1)(n+2)(n+3)}{1.2.3.4} + \ldots\ldots\right]$$

The last of the required five terms will contain x^4, hence, clearly, the terms will be—

$$1 + nx + \frac{n(n+1)}{1.2}x^2 + \frac{n(n+1)(n+2)}{1.2.3}x^3 + \left[\frac{n(n+1)(n+2)(n+3)}{1.2.3.4} - n\right]x^4.$$

(*b*) When $a + b + c$ is multiplied by itself n times, each term in the product is the result of taking *one* term, and one *only*, from each of the n factors $a + b + c$. To get the term $a^p\, b^q\, c^r$ we must choose a, p times, b, q times, and c, r times. Now a can be chosen p times in ${}_nC_p$ ways, and when it has been chosen in any of these ${}_nC_p$ ways, b can be chosen q times in ${}_{n-p}C_q$ ways. Hence p a's and q b's can be chosen in ${}_nC_p \times {}_{n-p}C_q$ ways. And when they have been chosen in any one of these ways, there is only one way of selecting r c's for $p + q + r = n$. Hence the required coefficient is

$${}_nC_p \times {}_{n-p}C_q = \frac{\lfloor n}{\lfloor p\ \lfloor n-p} \times \frac{\lfloor n-p}{\lfloor q\ \lfloor n-p-q} = \frac{\lfloor n}{\lfloor p\ \lfloor q\ \lfloor r}$$

44. (*a*) In how many ways can a council of seven members be chosen out of eleven candidates?

(*b*) In how many ways could the council be chosen, so as to contain two assigned candidates? (35.)

(*a*) Number of ways $= {}_{11}C_7 = \frac{11.10.9.8.7.6.5}{1.2.3.4.5.6.7} = \underline{330.}$

(*b*) If there are to be two particular canditates on the council, we shall require five others which may be chosen from nine candidates, hence the required number will now be

$${}_9C_5 = \frac{9.8.7.6.5}{1.2.3.4.5} = \underline{126.}$$

47. Show geometrically that sin 18° equals $\frac{1}{4}(\sqrt{5} - 1)$.

Let ABC be an isosceles triangle, having the angles at the base double the angle at the vertex (A); in AB take AD equal to BC and draw DE at right angles to AC; produce ED to meet CB produced in F; calculate the sides of the triangle CEF in terms of AB. (35.)

See 'Hamblin Smith's Trig.' Appendix.

$$A = \frac{180^\circ}{5} = 36^\circ.$$

$$EC = AC - AE = AB - AD\cos 36$$
$$= AB - BC\cos 36^\circ = AB - 2AB\cos 72^\circ \cos 36^\circ$$
$$= AB[1 - 2\cos 72^\circ \cos 36^\circ]$$
$$= AB[1 - 2\sin 18^\circ (1 - 2\sin^2 18)],$$
$$= AB\left[1 - \frac{\sqrt{5} - 1}{2}\left(1 - 2.\frac{6 - 2\sqrt{5}}{16}\right)\right]$$
$$= AB\left[1 - \frac{(\sqrt{5} - 1)}{2}\frac{4(\sqrt{5} + 1)}{16}\right]$$
$$= \frac{1}{2}AB.$$

$$FC = EC\sec 72 = \frac{1}{2}AB\,\mathrm{cosec}\,18^\circ = \frac{1}{2}AB\frac{4}{\sqrt{5} - 1},$$
$$= AB\frac{\sqrt{5} + 1}{2}.$$

$$EF = FC\cos 18^\circ = \frac{(\sqrt{5} + 1)}{2}AB.\sqrt{1 - \left(\frac{\sqrt{5} - 1}{4}\right)^2}$$
$$= \frac{1}{2}(\sqrt{5} + 1)\frac{\sqrt{10 - 6 + 2\sqrt{5}}}{4}AB$$
$$= \frac{1}{2}(\sqrt{5} + 1)\frac{\sqrt{10 + 2\sqrt{5}}}{4}AB$$
$$= \frac{1}{8}(\sqrt{5} + 1)\sqrt{2\sqrt{5}(\sqrt{5} + 1)}\,AB$$
$$= \underline{\frac{1}{8}(\sqrt{5} + 1)^{\frac{3}{2}}\sqrt{2\sqrt{5}}\,AB.}$$

48. Calculate the values of θ, less than two right angles, which satisfy the equations :—

(*a*) $\cos\theta = \sin 18^\circ 37' \cos 137^\circ 14'$,

(*b*) $\sin\theta = \sqrt{(\sin 10^\circ)}$. (35.)

$$(a)\ \cos\theta = \sin 18^\circ 37' \cos 137^\circ 14'.$$
$$= -\sin 18^\circ 37' \sin 47^\circ 14',$$
$$L\cos(180 - \theta) - 10 = L\sin 18^\circ 37' + L\sin 47^\circ 14' - 20,$$
$$L\cos(180 - \theta) = 9{\cdot}5041105^* + 9{\cdot}8657700^* - 10$$
$$= 9{\cdot}3698805.$$

L sin 13° 34′	= 9·3702847*	9·3698805	
13° 33′	= 9·3697608	9·3697608	
1′	·0005239	·0001197	

Therefore 9·3698805 is the L sin of 13° 33′ + $\frac{1197}{2335}$ of 60″, or 13° 33′ 13″·7, that is, the L cos of 76° 26′ 46″·3. We thus get 180 − θ = 76° 26′ 46″·3 or θ = 103° 33′ 13″·7, and another value would be 270° − 13° 33′ 13″·7 = 256° 26′ 46″·3.

(δ) sin θ = √sin 10°

L sin θ − 10 = ½ log sin 10° = ½ (L sin 10° − 10),

L sin θ = 10 + ½ L sin 10° − 5 = 5 + 4·6198351*
= 9·6194766.

L sin 24° 38′	= 9·6199378*	L sin θ	= 9·6198351
24° 37′	= 9·6196622	L sin 24° 37′	= 9·6196622
60″	·0002756	x″	·0001729

$\frac{x}{60''} = \frac{1729}{2756}$, or $x = 37''{\cdot}6$,

∴ θ = 24° 37′ 37″·6, or 180 − 24° 37′ 37″·6
= 155° 22′ 22″·4.

49. If √3 (tan² θ + sec 2θ − 7) + 10 = 0, find all the values of cos 2θ. (35.)

$\text{Tan}^2\theta = \frac{\sin^2\theta}{\cos^2\theta} = \frac{1-\cos 2\theta}{1+\cos 2\theta}$, so we get

$\sqrt{3}\left[\frac{1-\cos 2\theta}{1+\cos 2\theta} + \frac{1}{\cos 2\theta} - 7\right] + 10 = 0$, which gives

$(8\sqrt{3}-10)\cos^2 2\theta + (5\sqrt{3}-10)\cos 2\theta - \sqrt{3} = 0$,

$\cos^2 2\theta + \frac{5\sqrt{3}-10}{8\sqrt{3}-10}\cos 2\theta - \frac{\sqrt{3}}{8\sqrt{3}-10} = 0$,

$\cos^2 2\theta + \frac{20-30\sqrt{3}}{92}\cos 2\theta - \frac{24+10\sqrt{3}}{92} = 0$,

$\cos^2 2\theta + \frac{20-30\sqrt{3}}{92}\cos 2\theta + \left(\frac{10-15\sqrt{3}}{92}\right)^2 = \frac{24+10\sqrt{3}}{92} + \left(\frac{10-15\sqrt{3}}{92}\right)^2$

$= \frac{2983+620\sqrt{3}}{92^2}$;

$\therefore \cos 2\theta + \frac{10-15\sqrt{3}}{92} = \pm\frac{10+31\sqrt{3}}{92}$, from which

$\cos 2\theta = \frac{\sqrt{3}}{2}$ or $-\frac{5+4\sqrt{3}}{23}$.

50. A statue 30 feet high, standing on the top of a column, subtends at a point, distant 150 feet in a horizontal line from the base of the column, the same angle as that subtended at the same point by a man 6 feet high standing at the base; find the height of the column. (35.)

Let AB and BC represent the tower and statue, and AD the height of a man (6 feet) standing at the foot of the tower, then

Tan DEA = $\frac{6}{150} = \frac{1}{25}$, where E is point of observation.

$\text{Tan BEC} = \tan[\text{CEA} - \text{BEA}] = \frac{\tan \text{CEA} - \tan \text{BEA}}{1 + \tan \text{CEA} \tan \text{BEA}}$

$= \frac{\frac{x+30}{150} - \frac{x}{150}}{1 + \frac{x(x+30)}{150 \times 150}} = \frac{\frac{1}{2} \times 150^2}{150^2 + x^2 + 30x}$.

Now tan BEC = tan DEA = $\frac{1}{25}$,

$\therefore \frac{\frac{1}{2}\times 150^2}{x^2+30x+150^2} = \frac{1}{25}$, which reduces to

$x^2 + 30x = 90000$, which gives $x = 15(\sqrt{401} - 1)$.

51. Find expressions for r and R, the radii of the inscribed and circumscribed circles of a given triangle.

Express the ratio of r to R in terms of the angles of the triangle, and show that the maximum value of the ratio is ½. (40.)

The expressions for r and R may be found in any text-book of Trigonometry, $r = \frac{S}{s}$, $R = \frac{a}{2\sin A} = \frac{abc}{4S}$, where S is the area of the triangle.

$\frac{r}{R} = \frac{S}{s} \div \frac{a}{2\sin A} = \left[\frac{a^2 \sin B \sin C}{2\sin A}\right]\frac{1}{s} \div \frac{a}{2\sin A}$

$= \frac{a \sin B \sin C}{s} = \frac{2a \sin B \sin C}{a+b+c}$

$= \frac{\sin A}{\sin A + \sin B + \sin C} \times 2 \sin B \sin C$

$= \frac{2 \sin A \sin B \sin C}{\sin A + \sin B + \sin C}$

$= \frac{2 \sin A \sin B \sin C}{2 \sin \frac{A+B}{2}\left[\cos \frac{A-B}{2} + \cos \frac{A+B}{2}\right]}$

$= \frac{2 \sin A \sin B \sin C}{2\cos\frac{C}{2}\left(2\cos\frac{A}{2}\cos\frac{B}{2}\right)} = 4 \sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$.

Consider any one of the angles A, B, C to be fixed in value for a moment, say C. The product

$= 2\left(\cos\frac{A-B}{2} - \cos\frac{A+B}{2}\right)\sin\frac{C}{2}$

$= 2\cos\frac{A-B}{2}\sin\frac{C}{2} - \sin^2\frac{C}{2}$,

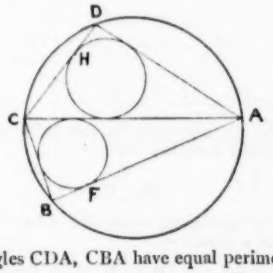
which has its greatest value, so far as A and B are concerned, when A = B, for then $\cos\frac{A-B}{2} = 1$. This informs us that so long as there are two angles *unequal*, the above product would be increased if these angles were *equal* (assuming the third angle to remain unaltered). Hence we infer that the product has its greatest value when no two angles are unequal, that is, when the triangle is equilateral, in which case $\frac{r}{R}$ is clearly ½.

Or the distance between the centres of the inscribed and circumscribed circles is $R^2 - 2Rr$ (see Text Book).

This cannot be negative, that is, 2Rr cannot be > R², or 2r cannot be > R, or $\frac{r}{R}$ cannot be > ½.

52. Given the sides of a quadrilateral inscribed in a circle, find an expression for its area.

The sides of a quadrilateral inscribed in a circle are *a*, *b*, *c*, *d*, taken in order; if *a* + *b* = *c* + *d*, show that the area of the quadrilateral equals *cd* tan $\frac{B}{2}$, where B denotes the angle between *a* and *b*. (40.)



The triangles CDA, CBA have equal perimeters (*s*).

Let their areas be S_1 and S, then $r = \frac{S}{s}$, $r_1 = \frac{S_1}{s}$.

∴ Area of quadrilateral = S + S_1 = *s*(*r* + r_1).

Now FB = *s* − *c*, and DH = *s* − *c*, where CA = *c*.

Also $r = (s-c)\tan\frac{B}{2}$, $r_1 = (s-c)\tan\frac{D}{2}$.

∴ area ABCD $= s\left[(s-c)\left(\tan\frac{B}{2} + \tan\frac{D}{2}\right)\right]$

$= \frac{a+b+c}{2}\cdot\frac{a+b-c}{2}\left(\tan\frac{B}{2} + \cot\frac{B}{2}\right)$

$= \frac{(a+b)^2 - c^2}{4}\left(1 + \tan^2\frac{B}{2}\right)\cot\frac{B}{2}$

$= \frac{(c+d)^2 - (c^2 + a^2 - 2cd\cos D)}{4}\sec^2\frac{B}{2}\cot\frac{B}{2}$

$= \frac{1}{4}\left[(2cd + 2cd\cos D)\sec^2\frac{B}{2}\cot\frac{B}{2}\right]$

$= \frac{1}{4}\left[(2cd - 2cd\cos B)\sec^2\frac{B}{2}\cot\frac{B}{2}\right]$

$= \frac{1}{2}\left[cd(1-\cos B)\left(\sec^2\frac{B}{2}\cot\frac{B}{2}\right)\right]$

$= \frac{1}{2}cd\,2\sin^2\frac{B}{2}\cdot\frac{1}{\cos^2\frac{B}{2}}\cdot\frac{\cos\frac{B}{2}}{\sin\frac{B}{2}}$

$= cd\tan\frac{B}{2}$.

OUR PUPIL TEACHERS' AND SCHOLARSHIP COURSE.

(*Continued from page* 30.)

Then the profits should be divided in proportion of 3,000 : 3,200 : 2,400, or 15 : 16 : 12.

Then A takes $\frac{15}{43}$ of £4,300 = £1,500;
B ,, $\frac{16}{43}$ of £4,300 = £1,600;
C ,, $\frac{12}{43}$ of £4,300 = £1,200.

The example should be carefully noted.

Third Year.

Boys.—Work :—Example LXX., Sections 1–4, Barnard Smith; Example CXLV., Nos. 361–410, Lock.

Girls.—Work as many general examples as possible on the Year's Work.

Send any for solution which present difficulty.

C.—*Music.*

First Year.—Mental effects and accents.

Selected Government questions :—

1. What are the mental effects of the following tones :—
ray, me, fah, soh, la, te?
2. Which note of the scale is most calm, which most sad, which most firm, and which most rousing?
3. What are the leaning tones of the scale? Why are they called leaning tones? Which tones lean most?
4. Which note of the scale is most satisfactory as a final note of a melody? Name two others which would be satisfactory, and two which would be unsatisfactory.
5. Give four ways in which the mental effect of tones may be modified, with an example in each case.
6. What is a pulse? What is a measure? When are double bars and brackets used?
7. What are the essential differences between two, three, and four pulse measures?
8. What measures are shown by the following pulse signs :—

(*a*) { : | : | ‖

(*b*) { : | : | : | : | : ‖

(*c*) : : | : : ‖

9. Re-write the following in four-pulse measure, doubling the value of every note and rest :—

{ | m. :s. | f :- .m | r : | d : — ‖

10. Write in figures over each note and rest its value in pulses or fractions of a pulse :—

{ | m :- .f :s. | f :— :m.r | d :— :— | :s.t_1:d ‖

Second Year.—Quarter pulse notes and rests. Thirds of a pulse.

Selected Government questions :—

1. Write in the primary form the pulse signs for (*a*) a six-pulse measure, (*b*) two three-pulse measures, (*c*) a nine-pulse measure, (*d*) a four-pulse measure.
2. Write in a secondary form three six-pulse measures, showing two three-pulse tones, a one-and-half pulse tone, a half-pulse rest, four quarter-pulse, a quarter pulse rest, a quarter pulse tone, a silent half pulse, five silent pulses, and a three-pulse tone.
3. Write distinctly over each note and rest its value in pulses or fractions of a pulse.

{ | m.r,d :s.,f :m | s : — :- .l |
| t. d' :s, f. m :r | s, f. m, f :m : — ‖

4. Re-write the following in two-pulse measure, halving the value of each note and rest.

{ | s :- .f | m : | f :s .f | m :s |
| d : — | r :-. m | f. s :f. m | r : ‖

5. Re-write the following in six-pulse measure, trebling the value of each note and rest.

| :m | s : | d_1 r_1 m : f_{11} |
| t_{11} d_1 r | m_1 —$_1$f | r :s | d ‖

Third Year.—Relative pitch of Keys.

Government questions :—

1. State the pitch (C. D. E., etc.) of the following notes, supposing the Key to be F :—

d' m t_1 d l s r' m

2. Which of the following is highest and which lowest in pitch?

Fah in Key G, *me* in Key B♭, *soh* in Key D, te_1 in Key C, *me* in Key A♭.

3. Which of the following is highest and which lowest in pitch?

Me in Key E, *ray* in Key B♭, *me*^{1} in Key D, *te* in Key A♭, *me* in Key F.

4. The following passage—d, t, r, s, d—is sounded in the keys of E♭, C, F, B♭, and D. In which will it sound highest and in which lowest? Give the pitch of the highest and lowest notes that would be sounded.

5. Arrange the following notes in order of pitch, and state the pitch (C, D^1, etc.) of each :—*Doh*^{1} in Key A, *ray* in Key F, *lah* in Key B♭, *soh* in Key G, *soh*^{1} in Key D.

6. Give the absolute pitch of *me* in Key A, *te* in Key F, *soh*$_1$ in Key G, *ray*^{1} in Key A♭, *lah*^{1} in Key C.

D.—*Spelling.*

Learn 50 words each week from 'Words commonly Mis-spelt,' or any good list. Test frequently by dictation.

E.—*Geography.*

British North America. Chief points :—

1. Note particularly the meaning of the term 'Dominion of Canada.' This is applied to a federation of states :—The provinces of Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward's Island, Manitoba, British Columbia; the territories of Athabasca, Alberta, Assiniboia, Saskatchewan, Keewatin, the North-West Territory, and the North-East Territory.

Besides its own local government, each province sends members to the central parliament, which meets at Ottawa. The territories have not that privilege.

Note that Newfoundland has not joined the Confederation, and is *not* part of the Dominion.

2. The general build of the country. (1) The eastern seaboard; (2) The valley of the St. Lawrence; (3) The great central plain; (4) The pine barrens and Arctic slope of the north; (5) The elevated district of the Rockies; (6) The Pacific slope.

3. The vast network of internal waterways. The St. Lawrence (with the Great Lakes, the tributaries of St. Francis, Chaudière, Ottawa, and Saguenay), Saskatchewan, Athabasca, Assiniboine, Red River, Churchill, Nelson, Mackenzie, Peace R., Columbia, and Fraser.

4. The climate. One of extremes in the centre, modified by proximity of sea in Columbia and the Eastern States.

5. Productions.

(*a*) Animal—Fur bearing animals of all kinds, wolf, moose, bear, buffalo; fish of all kinds, especially cod, ling, herring on the banks of Newfoundland, salmon in the Fraser and Columbia. Domestic—horse, cow, sheep, and goat. Dairy produce.

(*b*) Vegetable—Timber; forests of birch, cedar, maple, walnut, poplar, fir, spruce, pine (Douglas pine in Vancouver finest in the world), oak, and beech.

Wheat (in vast quantities), oats, rye, barley, maize, apple, vine, and all temperate fruit trees. Tobacco.

(*c*) Mineral—Silver, salt, petroleum, coal, copper, iron, and gold. (Make a list of places where each is found.)

6. Industries. Lumbering, hunting, agriculture, manufacture (sugar, etc.), mining, fishing, dairy farming, sheep ranching, etc.

7. Towns. The following towns should be entered in a map, their position accurately learnt and any particulars about them :—

Ottawa, Kingston, Toronto, Hamilton, London, Brantford, Quebec, Montreal, Three Rivers, Fredericton, St. John, Halifax, Yarmouth, Annapolis, Sydney, Charlottetown, St. John's, Winnipeg, Brandon, Regina, Qu'appelle, Medicine Hat, Calgary, Battleford, Victoria, Vancouver, Esquimalt, Harbour Grace, etc.

8. Education and religion.

9. The Canadian Pacific Railway, the ship canals, etc.

(Some useful information may be obtained from the illustrated guides published by the various shipping firms which run lines of steamers to Canada.)

Typical Government questions on British North America :—

1. Give an account of a voyage to Canada, and say all you know about Nova Scotia.
2. Describe the basin of the St. Lawrence.
3. Name the chief physical features, industries, and exports of Manitoba and British Columbia.
4. Describe a journey by the Canadian Pacific Railway, and show how it shortens the way to Australia.
5. What do you mean by the 'Dominion of Canada?' How is it governed, and how did we come to possess it?
6. Give an account of the climate and productions of British North America.
7. Where are the following and for what are they noted :—Ottawa, St. John's, New Westminster, Winnipeg, Baffin Bay, Mount Hooker, Labrador, Calgary?
8. What are the principal exports of Canada.
9. Say what you can about (*a*) lumbering, (*b*) fishing on 'The Banks,' (*c*) the fur bearing animals of the North-West.
10. Describe a journey by water from Duluth to Montreal. Illustrate your answer by a sketch map.

Practise memory maps regularly, and send a specimen in for criticism.

F.—*History.*

Revise the History from 827 to 1066 A.D.

Chief points :—The Danish invasions : their character and results—Saxon customs, laws, institutions, etc.—The chief writers of the period—The Norman influence.

Learn the meaning of all terms such as :—Witanagemote, shire moot, hall mote, folk moot, folcland and bocland, mund, were and wite, earl, sheriff, thane, ceorl, knight, alderman, huscarles, Danelagh, Danegeld, etc.

Typical questions on the period :—

1. Give some account of the invasion of the Danes.
2. Relate some particulars of the reigns of the elder brothers of Alfred the Great.
3. Mention some proofs of the wisdom of Alfred as a ruler, and describe his measures for promoting the education of his people.
4. How came there to be Danish kings in England?
5. Explain the terms earl, hundred, burgh, witanagemote, Danegeld.
6. Write a short account of the reign of Canute.
7. What do you understand by hundred, tithing, frankpledge, sheriff.
8. Point out the influence which the life and character of Edward the Confessor had upon the events occurring after his death.
9. Who was Dunstan, what do you know of him and his objects?
10. Who were Wilfred, Bede, Dunstan, and Godwin?
11. State with dates what you know of the following :—Hengist, St. Augustine, Offa, and Edgar Atheling.
12. Witan, earl, churl, alderman, sheriff, thane, villein. Explain these terms.
13. Who were the Normans? What intercourse had taken place between England and Normandy before the Conquest?
14. How was Edward the Confessor connected with Normandy? State the name and parentage of his wife.
15. Give some account of Saxon paganism.
16. What circumstances in the later Saxon period prepared the way for the Norman Conquest?
17. Give an account of the constitution and powers of the Witanagemote.
18. What do you know of the Anglo-Saxon Chronicle?
19. How do you account for Harold II. becoming king?
20. Explain the terms :—Wergeld, wapentake, theows, and folkmote.

G.—*Euclid.*

Second Year Boys.

Revise Propositions XX. to XXVI., and work as many deductions thereon as possible.

Third Year Boys.

Revise any propositions not thoroughly known, and work as many deductions as possible.

H.—*Algebra.*

Third Year.

1. Revise Theory of G.C.M. and L.C.M. Write for assistance if any difficulty is experienced.
2. Work the following paper :—
   (1) When $x = -4$, find the value of
   $3x + 20 - 4[17 - 9x - 4\{5(2x-1) - 4(3x-2)\}]$.
   Ans. -28.
   (2) Add together
   $16\{\frac{3}{4}a - \frac{3}{4}(b - \frac{1}{2}c)\}$, $12\{\frac{5}{6}b - \frac{1}{3}(c - \frac{1}{4}a)\}$,
   and $\frac{1}{3}\{(2a - 3b) - (6c - a)\}$.
   Ans. $8a - 3b$.
   (3) Resolve into factors—
   (*a*) $7x^2 - 15x + 2$. (*b*) $4a^2 + 4ax + x^2 - 9$.
   Ans. $(7x - 1)(x - 2)$; $(2a + x + 3)(2a + x - 3)$.
   (4) Solve the equation—
   $\frac{3}{5}(x - 5) - \frac{3}{11}(x - 13\frac{1}{3}) = 5 - \frac{1}{5}(7 - x)$.
   Ans. 17.
   (5) Simplify—
   $$\frac{x^2 + x - 6}{x^2 + 2x - 8} \times \frac{x^2 + 4x}{x^2 - 9}.$$
   Ans. $\frac{x}{x - 3}$.
   (6) Find the Highest Common Factor of—
   $2x^4 - x^3 - 10x^2 - 11x + 8$ and $2x^3 - 3x^2 - 9x + 5$.
   Ans. $2x - 1$.
   (7) In paying two bills, one of which exceeded the other by $\frac{1}{3}$ the less, the change out of a £5 note was half the difference of the bills. What were their amounts?
   Ans. £2 13s. 4d., and £2.

I.—*Teaching.*

Second Year.—Flux's 'School Management,' Chapter I.

Third Year.—Flux's 'School Management,' Chapter II.

Test knowledge by questions at end of the book, prepare answers where necessary.

TEST QUESTIONS.—ALL YEARS.

Penmanship.—Write as a specimen of Large-hand :—Llewellyn, Montgomeryshire.

Small-hand :—

> Do you hear the children calling, O my brothers?
> Ere the sorrows come with years.

Composition.—First years should practise the reproduction of a passage of average difficulty after reading once.

Second and Third Years.—Write an essay each week, selecting from the following subjects :—

> The effects upon commerce of mountains and rivers.
> Life in a new colony.
> Describe a fair.
> The use and abuse of travelling.
> The influence of trade on the growth of a nation.
> Write an account of the habits of bees or ants.
> Business habits.
> The Tower of London.

Geography.—1. Draw a map of England south of the Trent.

2. What are the chief industries of Queensland *or* British Columbia?

3. What articles do we export to our colonies, and what do we receive in return?

4. Where and what are the following :—Echuca, the Fens, Esquimalt, Rockhampton, Moor of Rannock, The Giant's Causeway, Lachine Rapids, Isthmus of Chignecto?

History.—1. Give some account of the manners and customs of the early Britons.

2. How did the Romans administer the province of Britain? Into what districts was it divided?

3. Relate what you know of the work of the early Roman and Irish missionaries.

4. Of the Saxon kingdoms one became predominant. Trace the rise of this kingdom.

First Year.

English.—1. Analyse the following passages from Gray's 'Bard': 76–80, 85–90, 101–106, 107–110.

2. Parse these words :—High (77), Rept (79), yet (79), fell (81), bray (83), ye (87), bending (95), deep (96), nor thus (101), here to mourn (102), no more (109).

3. Write a life of Gray.

4. Show the effect of the suffix by giving the meaning of the following words :—Frolicsome, knotty, clayey, woollen, leeward, awkward, knavish, friendly, bootless, sweetish.

Arithmetic.—(*Boys.*)—1. Reduce 12 acres, 2 roods, 12 poles, to the fraction of 2 acres, and multiply £37 10s. 0d. by the result. Ans. £235 15s. 7½.

2. Express as a decimal $\frac{55^2}{2^5 \times 5^3} + \frac{92^3}{2^3 \times 5^7}$. Ans. ·0058892.

3. Simplify $\frac{5\frac{3}{4} - 2\frac{2}{3}}{4\frac{2}{3} \text{ of } \frac{7}{18\frac{1}{3}}}$ and multiply the sum of ·0083 and ·8003 by 8·003. Ans. 61¼; 6·4712258.

4. Subtract $4\frac{3}{16}$ from $\frac{4}{21} + 13\frac{3}{10} + 2\frac{1}{7} + \frac{1}{6}$. Ans. 10⅔.

Girls.—1. If 14,400 lb. of wool were brought at 5½d. and sold at 6¾d. a lb., what was the gain? Ans. £90.

2. Simplify $6\frac{7}{8} - 8\frac{3}{4} + 7\frac{1}{2}\frac{1}{2} - 4\frac{1}{10}$. Ans. 1½.

3. Find by Practice the value of 73 quarters 4 bushels 3 pecks of wheat at £1 6s. 8d. per quarter. Ans. £98 2s. 6d.

4. In working Practice, what are the best parts of a £ to take for 5s. 8d. and 11s. 3d., of a shilling for 5½d.; of a cwt. for 24 lbs.; of an acre for 56 poles?

Music.—Answer test questions given above.

Second Year.

English.—1. Paraphrase and analyse lines 199-208 of 'The Traveller.'

2. Parse lines 209 and 210.

3. Give a list of the most important prefixes (English and Latin), and illustrate your answer by examples.

4. What is meant by inflexion? Give some examples and shew how the want of inflexions in our language is supplied.

Arithmetic.—(*Boys.*)—1. If the work done by a man, a woman, and a boy be in the proportion of 3, 2, 1, and if 12 men, 15 women, and 15 boys do a piece of work in 270 days, how long would it take 18 men, 12 women, and 12 boys? Ans. 243 days.

2. Two men, A and B, have £1,800 to invest. A invests in 3½ per cent. stock at 108, B in 2¾ per cent. stock at 96. Compare their incomes (no brokerage). Ans. 40 : 33.

3. Find the cost of painting the four sides and the bottom of a tank 3½ yards long, 3½ feet wide, and 6 feet deep, at 4d. a square foot. Ans. £3 8s. 3d.

4. In what time will £275 amount to £326 11s. 3d. at 5 per cent., simple interest? Ans. 3¾ years.

(*Girls.*)—1. Find the G.C.M. of 27781 and 23507, and show that no other number can be their G.C.M. Ans. 2137.

2. Simplify $\{(\frac{3}{4} \text{ of } 5\frac{1}{3}) + (1\frac{5}{6} \text{ of } 10\frac{2}{7})\} \div 10\frac{2}{7}$. Ans. 1⅓.

3. Find the value of $\frac{3}{4}$ of 9s. 11d. + $\frac{4}{11}$ of £1 10s. 3d. − $\frac{4}{17}$ of 12s. 9d. + 3½ of £3 19s. 6d. Ans. £14 8s. 10d.

4. Subtract $\frac{7}{11}$ of 4 tons, 13 cwt., 2 qrs., from $\frac{5}{8}$ of 6 tons 15 cwt., and express your answer as a fraction of 30 tons. Ans. $\frac{3}{176}$.

Euclid—1. Prove the converse of I. 5.

2. Prove that the diagonals of a square bisect each other at right angles.

Music.—Answer questions above.

Teaching.—1. Write notes of a lesson on Sugar or Bees.

2. How would you give a writing lesson to Standard II.?

Third Year.

English.—1. Paraphrase lines 173-188 of 'Essay on Man.'

2. Analyse lines 165-172.

3. Parse lines 165 and 166.

4. Name six prose writers of the 18th century, and give some account of their works.

Arithmetic.—(*Boys.*)—1. Explain the terms Brokerage, Consols are at par, Consols are at a discount. If I sell out £3,000 3½ per cent. stock at 112, and re-invest in a 4½ per cent. stock at 119, how much do I gain in annual income? Ans. £15.

2. A circular race-path is 1,078 yards round; two men start, back to back, to run round it, the one runs at the rate of 12 miles, and the other at 12½ miles an hour; when and where will they first meet? Ans. 1½ minutes, A goes 528 yards, B 550.

3. Three men fill a pit in 2½ hours, throwing in respectively 7, 12, and 14 shovelfuls of earth per minute. In what time would each man have filled up the pit by himself?

Ans. 11 hrs. 47½ mins.; 6 hrs. 52½ mins.; 5 hrs. 53¾ mins.

4. Having bought £40 worth of goods, I sell half at a gain of 10 per cent. For how much must I sell the remaining half so as to gain 30 per cent. on the whole? Ans. £30.

(*Girls.*)—1. If 375 hams, each weighing 19 lbs., can be bought for £399, how many hams weighing 17 lbs. can be bought for £210? Ans. 210.

2. Divide 66·761 by ·0661; divide ·047 by ·0021, correctly to three places of decimals. Ans. 1010; 22·3809.

3. A man leaves to two of his daughters $\frac{5}{13}$ and $\frac{4}{11}$ of his property and the rest to a third. The first received £12,507. What would the third have? Ans. £11,142 12s.

4. Find the value of ·025 of £3 5s. + ·07 of £2 1s. 3d. + ·05$\dot{3}$ of £1 0s. 7½d. + ·675 of 15s. Ans. 15s. 9½d.

Euclid.—1. Define parallelogram. The complements of the parallelograms which are about the diameter of any parallelogram are equal to one another.

2. PQR is a triangle; find a point S in PQ so that if ST be drawn parallel to QR, meeting PR in T, the sum of PS, ST shall be equal to PQ.

Music.—Answer questions above.

Teaching.—1. Write full notes of a lesson on Oil, Comparison of Adjectives, or a Slate Pencil.

2. By what means would you try to improve your children in punctuality and regularity?

Notes on 'The Bard.'

Lines 77–82 - Refer to Richard II.

,, 83–96 - To the Wars of the Roses.

,, 87 - There was a popular but erroneous impression that the Tower of London was commenced by Julius Cæsar. 'Lasting shame' because of the numerous murders and assassinations committed there.

,, 89 - *His*, that is Henry VI.'s.

,, 91–92 - 'The rose of snow,' and 'her blushing for,' refer to the white and red roses, the badges of the Yorkists and Lancastrians respectively.

,, 93 - 'The bristled boar.' Richard III. whose cognizance was the boar. This line and the next refer to the murder of the infant princes in the Tower.

,, 97–110 - A farewell to the past and a welcome to happier times, when the genuine kings (*i.e.*, those of Welsh descent) mount the throne. This refers to the accession of Henry Tudor or Henry VII., who was of Welsh extraction. (The historical references in these lines must be carefully read up.)

The 'Traveller.'

Lines 165–174 - Consideration of *Switzerland*. This is an entire contrast to Italy. It is rough, cold, bleak, the soil is barren, the climate cold, and the country subject to storms.

,, 175–198 - Yet even here there is happiness, produced by content. Although the peasant lives a hard life, he is not rendered discontented by seeing his neighbours rich and luxurious. He pursues his laborious occupations during the day, and at night enjoys the warmth and comfort of his humble hearth.

,, 199–208 - In fact the very existence of the discomforts by which he is attended only seem to bind him closer to his country and to render him more patriotic.

,, 209–226 - But if their wants are few, their pleasures are few. Their life is like a smouldering fire, which rarely bursts out into flame. Their minds are continually directed to small and unimportant matters.

,, 226–238 - The result of this cramping is that their morals, like their pleasures, are low. They seem incapable of the finer feelings of human nature, although they possess some rugged virtues.

,, 239–254 - Consideration of *France*. Gentler skies, more polite manners, and a bright, lively people who are fond of amusement and dancing.

Lines 255–264 - The French are most honourable and most anxious to please.

,, 264–280 - But they are superficial, and given to empty follies, and we find vulgar ostentation and illimitable vanity.

,, 281–296 - *Holland.* The character of the country, and the result of man's toil.

,, 296–316 - The Dutch are most industrious; but their industry leads to wealth, and their wealth to avarice, craft, and fraud, and the land is a land of tyrants and a den of slaves.

,, 317–334 - *Britain.* A patriotic description of Britain and its people. The men are 'lords of the human kind.'

(*N.B.*—Messrs. Macmillan & Co. have issued a capital edition of 'The Traveller,' with copious notes, price 1s. I should advise all second-year P.T.'s to procure a copy.)

'*Essay on Man.*'

Lines 1–16 - These lines set out the object of the poem, and may be freely rendered thus:—Come, my friend, let us leave the consideration of earthly affairs, which ambitious persons or those in responsible positions give such attention to, and, since life is brief, let us together ponder over the position of man in this world. It is a mighty maze, but it is not without a well-defined plan if one is carefully sought. The human world may be compared to a wilderness, where both flowers and weeds grow together; or to a garden with all kinds of fruit—some good, some bad. Let us explore life in all its relations, study the laws of Nature, laugh at the foily of human manners and fashions; but let our chief object be to prove to man that the ways of God are always right and just.

,, 17–50 - In discussing man's station and God's dealings with him, we can only reason from what we see and know, and though we may examine the human race completely, we can only estimate the power of God partly: we see only this particular planet. God surveys the whole solar system, and not only that, but the whole universe, containing countless systems of worlds, each of which may be inhabited by a race of beings suited to it by God's infinite wisdom. Since our minds are illimitably small as compared with the omniscience of the Deity, we must confess that we are not so well situated to judge of the moral, mental, and physical suitabilities of man.

The main line of thought is here introduced, and should be carefully thought out. Man is not an imperfect being, but a perfect being for the state in which he is placed and the work he has to do. He cannot grumble because he is not more intellectual, of higher morality, or stronger physical constitution, any more than a coral insect could. From the lowest form of life to the highest (that is God) there is a perfect gradation, and somewhere in that scale there must be such a being as man. He is not to grumble at being no higher, but to be thankful that he is no lower.

,, 50–75 - 'We are very often apt to say that, with regard to man's actions and positions, they are wrong; but although they appear so from our point of view, they must be a part of some great divine scheme, into which they fit with perfect appropriateness. Man's work may be purposeless and useless, but God's cannot be so. Our erroneous judgments arise from the fact that we can only see a very small part of God's purpose, and, therefore, are not in a position to form a correct judgment.

'A horse might fail to understand why at one time he is urged to his utmost speed, and at another checked; or an ox, why in some places he is used for ploughing or other hard work, and in other places worshipped as a god. But it does not follow, because *they* do not understand, therefore something is wrong. So with man—he does not understand why he suffers the changes of fortune, and may be sometimes master, sometimes slave. But these changes are doubtless a part of a complete and perfect plan formed by the Deity.'

Lines 75–112 - An exact knowledge of the future is mercifully withheld from man. He can only see and know the present. Heaven hides from brutes what men know, and, similarly, it hides from man what spirits know. If this were not so, life would be intolerable, for we should be always overwhelmed with the thought of coming evil. Take the case of a lamb, which man dooms to death. Its ignorance of the future allows it to skip and play up till the moment of its death; but, if it had reason, the thought of approaching death would deprive it of all pleasure in its life.

This blindness of the future is kindly given by Heaven; yet, though we know it not, the fate of each is watched over and decided by God, who is cognisant of everything that takes place, from the death of a hero to that of a sparrow, and from the bursting of a bubble to the destruction of a world. Nothing is too little and unimportant to escape His knowledge and decision.

What, then, is our duty? Not to expect perfection of happiness here, but to hope for it in the future, to do our appointed work in this life, and patiently wait for the great revealer of secrets—Death. We cannot know what happiness may be ours hereafter, but to counteract this deficiency we have the blessing of eternal hope. No man is ever perfectly happy in this life; that state is reserved for the future. The soul instinctively turns from the toil and trouble, pain and sicknesses, cares and anxieties of this life, and looks forward to 'God, who is our home.'

That this anticipation is not the result of civilisation is exemplified in the case of the Indian. His mind, destitute of all the knowledge of science and civilisation, looks forward to a heaven, although his ideas can only present to him some happy hunting-ground, where there will be no more slavery and no oppression by the white men. (This passage, lines 99-112, are always regarded as some of the finest of Pope's lines.)

(N.B.—In answer to several requests, arrangements have been made to mark, correct, etc., the answers to test questions monthly at the charge of one shilling. Solutions in full will be supplied where necessary, and hints, etc., given on all the points on which improvement is needed.)

SCHOLARSHIP COURSE FOR DECEMBER, 1895.

Work for the Month.

Continue practice in Reading aloud, and writing copies daily.

1. *Spelling.*—250 words from 'Words Commonly Mis-spelt,' or any other good list.

2. *Composition.*—Write one or two essays each week, selecting the subjects from the following:—

A bank holiday.
'There's many a slip 'twixt the cup and the lip.'
Sunshine.
A morning in a museum.
'Waste not, want not.'
A hard winter, its causes and results.
Second thoughts are best.
Punctuality.
Public gardens and parks.
The importance of accuracy in little things.

(An essay should be sent in occasionally for examination and criticism.)

Draft an analysis of each before writing and enter in note book.

Read up the subject, if necessary, but do not refer to books while writing.

3. *English.*—1. Analyse the following, and parse the words in italics:—

(*a*) *As* in an evening, when the gentle air
Breathes to the sullen night a soft *repair*,
I oft have sat on Thames' sweet bank, *to hear*
My friend with his sweet touch *to charm* mine *ear*
When he hath played—*as well he can*—some strain
That *likes me, straight* I ask the *same again*,
And he, *as gladly granting*, strikes it o'er
With some sweet relish was forgot before.

(*b*) As the introduction of these representations had been an improvement upon those plays which consisted of scriptural characters *only*, *so* was the introduction of historical personages an improvement upon *those* which employed *only* a set of impersonated ideas. It was soon found *that* a real human being, with a human name, was better calculated to awaken the *sympathies* and *keep alive* the attention of an audience, and *not less* to impress them with moral truths than a *being* that *only* represented an idea of the mind.

2. Learn 50 roots with meanings and examples per week.

3. *Literature.*—Enter into a note book brief lives of the following writers, with their chief works, and brief descriptive notes :—

Richardson, Fielding, Smollet, Hume, Gibbon, Adam Smith, Burke.

Revise the grammar of the verb fully and completely.

4. *Arithmetic.*—Work the following :—

1. At what time are the hands of a watch exactly in opposite directions between 2 and 3, 9 and 10, 5 and 6.

Ans. $43\frac{7}{11}$ past 2 ; $16\frac{4}{11}$ past 9 ; 6.

2. If A can beat B by 31 yards, and C by 18 yards in a race of 200 yards, how many yards can C give B in 350 yards?

Ans. 25 yards.

3. Two engines, 40 miles apart, approach each other at the rates of 25 and 35 miles an hour. Determine the time and place of their meeting.

Ans. 40 minutes ; $16\frac{2}{3}$ miles from A.

4. In a circular running path, whose distance round is $\frac{3}{4}$ miles, A and B walk the same way ; A walks 4 miles an hour, and starts 30 minutes before B, who walks $4\frac{1}{2}$ miles an hour. When will B overtake A? Ans. 1 hour.

5. Of a piece of work 2 men and 5 boys do half in 5 days, 3 men and 4 boys can do a third in 3 days. In how many days could 9 men do it? Ans. 5.

6. In what proportion should oats at 3s. a bushel be mixed with peas at 8s. a bushel, that the mixture may be worth 5s. a bushel. Ans. 3 : 2.

5. *Algebra.*—(*Girls.*)—G.C.M. and L.C.M.

Pay especial attention to factors, and use them in working as much as possible. Send up any difficulty for solutions and assistance.

(*Boys.*)—Continue practice on Simultaneous Equations of two Unknowns Problems.

6. *Euclid.*—Book II. Props. V.–IX. Note the algebraical equivalents to the propositions. Practise writing out. Work as many deductions as possible, at least five per week.

7. *Geography.*—British North America. For chief points see under Pupil Teachers' Course above. Practise memory maps, and send one in for criticism occasionally.

In preparing the geography utilise the information contained in Geographical Readers, Books of Travel, etc.

8. *History.*—Henry VIII. Chief points.

(*a*) Character. At first affable, witty, and learned, afterwards an absolute tyrant, without pity or remorse.

(*b*) *Henry and France.* Nothing important. Henry liked to feel he held the balance of power between the King of France and the Emperor.

(*c*) The divorce and its results. Very important.

(*d*) The Reformation, and suppression of the monasteries. The pilgrimage of grace.

(*e*) Henry's victims :—Two wives, Anne Boleyn and Katherine Howard, Sir Thomas More, Bishop Fisher, Buckingham, Montagu, Marquis of Exeter, Countess of Salisbury, and the Earl of Surrey.

(*f*) Learn lives of Wolsey, More, Cromwell, and Cranmer.

(*g*) Prepare the following note.

The Reformation.

1. *Early Attempts at Reformation.*

1. The Albigenses, who rose in insurrection during the Pontificate of Innocent III. and were crushed by De Montfort.

2. The Lollards, in England and Bohemia in the fourteenth century, who were arrested by the Council of Constance reforming some of the most scandalous abuses, and instituting a merciless persecution.

2. *Causes which contributed to the Progress of the Reformation.*

1. The great papal schism, when there were two popes, each asserting his own infallibility.

2. The vices of the Roman Court, especially under Alexander VI. and Julius II.

3. The immoral lives of the clergy, and the custom of *Benefit of Clergy*, by which crimes could be committed with impunity.

4. The jealousy of the laity towards the wealth of the clergy.

5. The invention of printing, by which the Scriptures and writings of the Reformers were rapidly circulated all over Europe.

6. The great revival of learning about the beginning of the sixteenth century.

3. *Reformation in Germany.*

The immediate cause was the sale of indulgences to raise money to complete St. Peter's at Rome. The purchasers of these indulgences obtained, it was said, absolution from their sins, and exemption from purgatory after death. Tetzel, head of the Dominican Friars, sold them everywhere with shameless indecency. He was opposed by Martin Luther, who was excommunicated in 1520, summoned before the Diet of Worms, imprisoned, and afterwards released. He published a German translation of the Scriptures. In 1529 the Reformers were first called *Protestants* from their protesting against the decision of the Diet of Spires. In 1530 they presented their famous *Confession of Faith* at Augsburg. This was drawn up by Melancthon, one of the most famous scholars of the age, and, though moderately worded, placed insuperable difficulties in the way of reconciliation. In 1530 the Protestant States entered into the League of Smalcalde for self defence, and the rupture was complete.

4. *Reformation in Switzerland.*

Zwingle began, like Luther, by opposing the sale of indulgences, but he inculcated milder doctrines than the German. After his death Calvin succeeded him, and established a church republic at Geneva.

5. *Subjects of Controversy.*

The Reformers did not agree at all in their ideas, and the consequent disputes retarded the progress of the Reformation. Luther's followers called themselves Evangelical Christians ; the followers of Calvin, 'The Reformed Church.' The Calvinists believed in absolute predestination and government of the church by elders—the modern Presbyterian. The point which drew forth most discussion was the doctrine of Transubstantiation.

6. *Reformation in England.*

(*a*) *Henry VIII. was not a Reformer.* The separation from Rome in 1534, and suppression of the monasteries in 1535–6, had so humbled the English clergy that they did not oppose any measure which the King brought forward. Henry was not a heretic like Luther ; he denied no doctrine of the Romish Church. He only separated himself from their communion, denied papal jurisdiction, and declared himself Head of the Church. He persecuted alike the Protestants and those who believed in the Pope's supremacy.

(*b*) *Articles of* 1536.

In 1536 the King published a book of articles to settle all differences. These articles declared the necessity for belief in—

(*a*) The Three Creeds.

(*b*) Worship of images. The invocation of saints were enjoined as highly profitable.

(*c*) Transubstantiation and masses for the dead.

These were embodied in the Bishops' Book, 1537.

(*c*) *Publication of the Scriptures.*

1. Wycliffe's Bible.

2. A translation based on Wycliffe's, but strongly tinged with Lollard opinions.

3. Tyndale's (1530 and onwards) New Testament first, then the Pentateuch.

4. Miles Coverdale's, 1535. Published at Hamburg.

5. Matthew's, 1537. Reprinted in 1538 as Cranmer's, or the Great Bible.

(From this the Prayer Book version of the Psalms is taken.)

(*d*) The contest between Catholicism and Protestantism was continued in England till 1689. The various stages will be noted under the successive reigns.

9. *School Management* (Flux: Chapter XI.).—The recent introduction of Varied Occupations and Object Lessons renders this section of school management very important, and a question on it may be confidently expected. The regulations in the Code and the instructions to H.M.I.'s should be carefully read and noted. Test reading by means of the collection of questions at the end of the book.

10. *Domestic Economy.*—The treatment of common wounds and accidents.

11. *Music.*—The minor mode, its construction, intervals, forms, and uses.

12. *French.*—10 pages of 'Le Trésor.' (For translation see *Girls' Mistress*, weekly.) Prepare the Grammar of the adjective, noting formation of the plural, of the feminine, and comparison.

Test Questions.

1. Say what you can of the life and writings of Dr. Samuel Johnson.

2. Explain fully, with examples, how the lack of inflexions is supplied in the English language.

3. Give the derivations of the following words and use them in a sentence:—Factitious, despondency, federation, simple, capricious.

4. Give any examples you can of words which have changed their meaning since their introduction into the language.

5. (*Girls.*) (1) Simplify
$2l-\{2m+[n-(l-3m+n)]\}-(4n-m)$.
Ans. $3l-4m-4n$.

(2) If $a=3$, $b=2$, $c=-4$, $d=0$, find the value of $\sqrt{c^2+a^2}-(b-da)^2$. Ans. 1.

(3) Add together
$7a-8b-11c$, $3c+2a-8b$, $-5b-3a+11c$.
Ans. $6a-21b+3c$.

(4) Multiply $-a^2+3ab+b^2$ by $3ab-b^2+a^2$.
Ans. $11a^2b^2-a^4-b^4$.

(*Boys.*) (1) If $a=-3$, $b=2$, $c=3$, $x=-1$, find the value of $ba^c-ax^{bc}+xa^b$. Ans. -60.

(2) Subtract $\frac{1}{2}\{6(a^2-2a-1)-(a^2-7a+4)\}$ from $28\{\frac{3}{7}(a^2+2a)-\frac{3}{4}(a+\frac{1}{3}a^2-\frac{1}{3})\}$. Ans. $4a^2+4a+5$.

(3) Solve
(i) $\cdot 2x-\frac{\cdot 3x-8\cdot 13}{\cdot 21}=x-17$. Ans. 25.

(ii) $x+z=y+2=3x-7=2x+y-3z+13$.
Ans. $x=8$, $y=15$, $z=0$.

(4) If the divisor is $a^4+b^4-a^2b^2$, the quotient a^3+ab^2, and the remainder ab^6, find the dividend. Ans. a^7+2ab^6.

(5) Find the L.C.M. of
$1-4x+3x^2$, $1-9x^2$, $1-6x+9x^2$.
Ans. $(1-x)(1+3x)(1-3x)^2$.

(6) Extract the square root of
$36x^2+40x+25-14x^3+9x^6-20x^4-12x^5$.
Ans. $3x^3-2x^2-4x-5$.

(7) Simplify $\dfrac{(y+z-2x)^2-(z+x-2y)^2}{(x+y+z)^2-(x+y-5z)^2}$.
Ans. $\dfrac{x-y}{4z}$.

(8) How many yards of paper a feet wide will be required for the walls of a room x feet high, y feet broad, and z feet long, allowing n square yds. for doors and windows?
Ans. $\dfrac{2x(y+z)-9n}{3a}$.

6. (*a*) Give an account of the chief gold fields of Australia.
(*b*) Draw a map of British India.

7. (*a*) What were the results of the Wars of the Roses?
(*b*) By what schemes did Henry VII. make his throne and succession secure.

8. (*Boys.*) (1) If two straight lines cut one another, the vertical or opposite angles shall be equal. If T be the middle point of the diagonal QS of a quadrilateral PQRS, whose opposite sides are equal, then PTR are in a straight line.

(2) Prove I. 32. PQ, PR, the equal sides of an isosceles triangle PQR, are produced to S and T, so that PS, PT are equal. RS, QT intersect at M. If the angle SQT is equal to the angle PQR, then the angle SMQ is equal to twice the angle QPR.

(3) Find a point in the diagonal produced of a square, from which, if a line be drawn parallel to any side of the square, meeting another side produced, it will form, with the produced diagonal and the produced side, a triangle equal to the given square.

9. (*Girls.*) (1) What are the materials of which soap is made? Name any other washing materials.

(2) What is the difference between linen and cotton? Say for what purposes and when either is preferred to the other.

(3) What is the most economical mode of cooking meat? Give your reasons and describe the process.

(4) Describe, as fully as you can, the origin, preparation, and use of the two principal animal products used in this country for clothing.

10. (1) Re-write the following, (*a*) doubling the value of every note and rest, and (*b*) again halving the value of every note and rest.

| s : — | :r | m :—. d | r. d :t_1 .d |

(2) Name the following intervals:—

{d' / m}	{m' / f}	{ta / r}	{d' / re}	{se / t}	{f / de}

(3) Name the following relations of the minor or *lah* mode:—(*a*) Dominant; (*b*) Minor, or essential sixth; (*c*) Leading note, or essential seventh; (*d*) Supertonic.

(4) Explain the following terms:—Adagio, Crescendo, Legato, Accelerando, Retard, Lento, Con Brio, Calanda, M. 60.

CORRESPONDENCE.

1. Individual assistance will be given as far as possible by advice, solution of difficulties in any subjects, model answers, etc.
2. Specimens of Writing, Paraphrasing, Maps, Composition, etc., will be marked and criticised gratis.
3. To assist students in rural districts, Freehand or Model Drawings will be corrected and marked, with hints for improvement, etc., and returned if accompanied by a postage stamp.
4. As a rule, all replies will appear in the Correspondence Column, but anyone desiring an immediate reply may obtain it by enclosing a stamped, addressed envelope.
5. To ensure an answer in the next issue queries must be sent by the 15th of each month.
6. Name and address of sender, with coupon of current number of the Practical Teacher, and *nom de plume* if desired, must be enclosed.

All communications and queries with regard to these courses to be addressed to Arthur T. Flux, 12, Lower Park Road, Belvedere, Kent.

ANSWERS TO CORRESPONDENTS.

Argyle.—If $x^2+ax+576$ is a perfect square, what is the value of a? In a trinomial of this form, if a perfect square, the coefficient of the second term is the square root of the third term multiplied by 2. This may readily be seen, for considering such examples as $(x+3)^2=x^2+6x+9$ $(x+7)^2=x^2+14x+49$, &c., $\therefore 2\sqrt{576}=2.24=48$. *Ans.*

Science Subject I.—No marks are given for a pass in Geometrical Drawing, but 40 for a pass in the whole of Elementary Stage Science Subject I.

Fanny M.—There is no translation of *Le Trésor* published in book form, but you will find two—a literal and a free—running through the *Girls' Mistress* weekly.

Answered by Post.—W.M. (Dumfries); A.W. (Hull); E.W.B. (Blackpool); E.M.A. (Llanelly); E.J.S. (Bridgewater); Claudia (Silloth); H.W.C. (Swaffham); L.P. (Diss); G.P. (Clitheroe); G.L. (Stanley); R.M.P. (Godalming); L.T.B. (Madeley).

OUR 1896 CERTIFICATE CLASS.

BY J. C. HOROBIN, M.A.,
Principal, Cavendish College, Cambridge.

The subjects, failure in which excludes from a certificate, are marked (*f*). Optional subjects are marked (*o*).

FIRST YEAR.

Subjects.	Maximum Marks.	Men.	Women.	Notes.
Reading - - (*f*)	50	Same - - -	'As you like it'; 'Anne of Geierstein' - - -	It is advisable to get a good edition, such as the Clarendon Press or Temple 'Shakespeare,' and to read a little every day, paying special attention at first to the rhythm. ☞ FOR PUBLISHED PRICE OF BOOKS RECOMMENDED, SEE OUR ADVERTISEMENT COLUMNS.
Repetition - (*f*)	50	Same - - -	300 lines - - - - -	The set book for the English does not fulfil the requirements. Students are free to choose their lines from Milton, Byron, Wordsworth, or Tennyson, keeping in mind in their selection of passages that they can materially help their English by choosing passages which will illustrate— (*a*) The distinctive style of the author. (*b*) Peculiar constructions or rhythm. (*c*) Passages renowned for their descriptive or didactic beauty.
Penmanship - (*f*)	75	Copy setting, text and small. General character of writing -	Same - - - - -	Hughes's 'Certificate Copy Book.' Students should endeavour to make their ordinary hand of the same style as they adopt in copy setting.
Spelling - - (*f*)	100	Dictation - -	Same - - - - -	There are two difficulties in this exercise— (*a*) Verbal. (*b*) Phrasing. The first is best prepared for by (1) reading every day a few lines from an author like Gibbon or Macaulay, noting every word as a collection of letters, and (2) in writing from dictation short lists of words which the student has found difficult. The second is much more difficult to do well, as it requires— *(1) A good knowledge of part of the grammar. (2) A well-trained ear.

School Management. (*f*)	100	Same - - -	(1) General principles.
			(2) Methods of teaching—
			(*a*) Elementary subjects.
			(*b*) Class subjects.
			(*c*) Drawing.
			(3) Methods and principles of—
			(*a*) Infant teaching.
			(*b*) Infant discipline.
			(*c*) Cultivating the intelligence.
			†(4) Notes of lessons.
			(5) Training of senses and memory, and order of development of faculties.
				It is not easy to find a book giving the sort of aid that is required for the first section. Cowham's 'Oral Training' is good, but general principles are best studied incidentally in such books as Quick's 'Educational Reformers,' Spencer's 'Education,' and in Articles such as those by Mr. Cartwright in the PRACTICAL TEACHER of last year.
				For (*a*) and (*b*) of the second section see Flux's 'School Management.'
				For (*c*) the special Articles in the PRACTICAL TEACHER by Mr. Buffery Ridge give good hints.
				Sec. (3) is dealt with in Flux up to the standard of scholarship, but useful additional matter may be obtained from Gladman's 'School Work,' and every infant teacher should take the *Infants' Mistress* and study carefully the Articles therein referring to their particular work, especially to courses illustrating (*c*).
				For (5) Sully or Lloyd Morgan's books are good.

Music - - (*o*)	40	Same - - -	Definitions, musical terms, note values, time names and values, key transcriptions, scales and their relations.	Every student ought to attempt this paper. Dunstan's 'Manual' or Curwen's 'Standard Course' give all and more than is required.

* For (1) see Dr. Beach's 'English,' pages 124–129 and 161, 162. For (2) the best preparation is to get a good reader to read several of the passages that have been set before, or if this be not possible, the student should read the passages aloud, noticing carefully the effect on reading them as marked or differently.

† There is no part of the S.M. paper in which the practical teacher ought to score more than in Notes of Lessons, because no part lends itself more easily to originality. But the student should carefully note that the Examiner has to assess the *teacher*, not the *student*, and, therefore, METHOD or HOW is more important than *matter* or *what*. The most common errors are—

(*a*) To give more matter than can be dealt with in the time allowed for the lesson.
(*b*) To give matter unsuitable to the average calibre of the chosen class.
(*c*) To be irrelevant and out of proportion in the introductory matter.
(*d*) To give the matter and method *per saltum* and not by process of continuous development.
(*e*) To ignore or forget the principles which the candidate has probably enunciated in another part of the paper.

Sections 2 and 3 presuppose a knowledge of the requirements of the Education Code. The N.U.T. edition is the most suitable for the student's purposes.

Subjects.	Maximum Marks.	Men.	Women.	Notes.
Composition - (*f*)	30	Same - - -	Plain prose on a given subject.	A separate paper is now set in this subject, lasting one hour. Practice is the only way to obtain facility, and general reading provides the material. An exercise should be done at least every week. In selecting a subject take such an one the matter of which is well grasped. Arrange the order of treatment before beginning to write. Be sparing of quotations, and let the diction be as simple as possible. Make the paragraphs distinctive and self-contained. The golden rule, so far as the Examination is concerned, seems to be, Let the exercise be a good model for the upper standard of a school. Useful hints and exercises will be found in Dawson's 'Essay Writing and Paraphrasing.'
English - - (*f*)	100	Same - - -	(1) Parsing. (2) Analysis. (3) Principles of Grammar. Grays Poems, Milton's Tractate on Education.	The first three sections are well dealt with in Beach's 'English' and Dickinson's 'Difficulties of Grammar.' Macmillan & Co. publish Gray's Poems and the Tractate. The paper distinctly and definitely follows the syllabus, and it is as necessary to be well acquainted with the literature of the set book as to be able to analyse and parse. Speaking generally, if the exercises for parsing are taken from the piece to analyse, it is better to do the analysis first. The parsing then gives a check on the analysis and should agree with it. If the words for parsing are given in detached passages, the student will find it prevent many mistakes if the passage is analysed roughly on the scrap.
Geography -	75	Same - - -	(1) (*a*) Shape, size, and motions of the earth. (*b*) Atmosphere, rain, clouds, and vapour. (*c*) Winds, currents, and tides. (*d*) Cause which affects climate. (*e*) Effect of climate upon industry, productions, and national character. (*f*) Distribution of plants and animals.	Gregory's 'Physical and Astronomical Geography' and 'The Planet Earth,' with Brook's 'Descriptive Geography,' will quite cover the ground. The motions of the earth, vapour, currents, and tides require the most careful attention. The historical, ethnographical, and commercial parts of geography are receiving more and more attention by the Examiners.
History - -	75	Same - - -	(2) British Empire— (*a*) 1066–1815. (*b*) 16th century.	Boyd Carpenter and Green's 'Outlines'; Green's 'Main Facts.' Davies' 'Historical Manual' for the period. Epochs of English History— (*a*) Early Tudors. (*b*) Age of Elizabeth.
Arithmetic - (*f*)	100	(1) Arithmetic generally. (2) Explain and prove the rules. (3) Explain best methods of solving sums mentally.	(1) Arithmetic generally. (2) Explanation of the best methods of solving sums mentally, and of the processes employed.	Dixon and Beach's 'Girls' Arithmetic'; Wollman's 'Arithmetic'; Pendlebury, an excellent collection of difficult problems; Piper's 'Mental Arithmetic.' Section (6) is new, and is put in the place of the old exercise. Students may expect questions which will test their powers of introducing new rules to a class by 'preparatory oral exercises.' In the men's syllabus, section (2) is very important. Since algebraic symbols are allowed, the algebraic proofs of the rules are the best to give. The *explanations* of rules should follow the standard text books, such as Dixon or Pendlebury.

WOMEN ONLY.

Subjects.	Maximum Marks.	Syllabus.	Notes.
Domestic Economy.	75	(1) Food. (2) Clothing. (3) Fresh Air. (4) The Home.	Hughes's Domestic Economy—pages 85–99, 100–124, 135–146, 149–162, 213–245, 377–409.

Subjects.	Maximum Marks.	Syllabus.	Notes.
Needlework - (*f*)	100	(1) Repairing any plain article of underclothing. (2) Diagrams— (*a*) Woman's chemise. (*b*) Infant's shirt. (*c*) Pair of drawers for a child of five. (3) Cutting out and making two of the above. (4) Questions on Needlework.	Useful hints will be found in Miss Warren's book for section (4), and Miss Rosevear's Manual covers the full course. Perhaps the most frequent failure at the Examination is neglect of proper proportions in the parts of the garments set for different ages. This is entirely due to neglect in observing that some parts of the body alter materially in size in, say, two years, whilst others practically remain stationary. For example, a child of four will require a neck almost as wide as a child of six on the average, but the body length will be quite different as a rule.

MEN ONLY.

Subjects.	Maximum Marks.	Syllabus.	Notes.
Algebra and Mensuration.	100	Four simple rules. Involution and Evolution. Common Measures and Multiples. Fractions. Surds. Ratios. Proportions. Simple Equations and Easy Quadratics of one or two unknown quantities. Variations. Progressions. Mensuration of plain rectilinear figures and circle.	C. Smith's 'Elementary Algebra'; Henchie's 'Mensuration'; Horobin's 'Certificate Tests in Algebra and Mensuration.' (This contains the last ten years' questions arranged under the different rules, and full solutions are obtainable.) The Examiners expect the book-work to be thoroughly known, and it is important to notice that, though algebra may be used in an arithmetic paper, arithmetic illustrations in an algebra paper are worthless.
Euclid - -	100	First three books.	Deighton's is one of the best of the modern Euclids. Euclid's *order of propositions must be maintained*, but the proofs may be Euclid's or otherwise.

SECOND YEAR.

Subjects.	Maximum Marks.	Men.	Women.	Notes.
Reading - - (*f*)	50	Same - - -	Set Book— (*a*) Any two of— Golden Treasury of Songs and Lyrics (two books). Trial and Death of Socrates (Church) Frondes Agrestes (Ruskin). (*b*) Unseen. To show improvement— (*a*) Expression. (*b*) Modulation. (*c*) Correct delivery of long or involved sentences.	All H.M. Inspectors are paying more attention to reading, and the student will not find it easy to get full marks. Continuous practice in reading aloud with someone who is a good elocutionist is the best preparation. Some useful hints will be found in Hawkins' 'Reading and Reciting.'
Repetition - (*f*)	50	Same - - -	300 lines from a play of Shakespeare.	Generally as in First Year. The Clarendon Press edition of 'Richard II.' is one of the best, as the notes are suitable for the English paper, and the text is good. The lines might well be distributed over the three plays chosen for the English.
Penmanship - (*f*)	75	Same - - -	As in First Year.	
Spelling - - (*f*)	100	Same - - -	As in First Year.	
School Management. (*f*)	100	Same - - -	(1) Teach a class. (2) Organization. (3) Registers and Returns.	Students will find the National Society's 'Complete Register' a great help in getting facility. The N.U.T. edition of the Code gives specimens of all the forms that have to be filled up.

Subjects.	Maximum Marks.	Men.	Women.	Notes.
			(4) Processes of reasoning and the formation of habits and character. (5) Laws of Health. (6) Quick's Educational Reformers, chaps. 13, 16, 17, 18.	Section (4) is well dealt with in Cartwright's 'Mental Science and Logic.' On Section (6) see First Year. On Section (5) the student ought to read carefully the Instructions to Inspectors, and the Circulars of the Department respecting schools, playgrounds, etc. Sections (2) and (5) are dealt with fully in one of Cowham's 'Manuals,' or Gladman.
Music— (*a*)		Same - - -	Staff-notation.	
Theoretical Practical -	30 50		1. Notes. Their position on the treble and bass staves. All the major and minor scales. Diatonic and chromatic intervals. [Transposition.] 2. Time. The value of notes, dotted notes, tied notes, and rests. Signatures of all the simple and compound times. Accent and syncopation. Contents of bars. Transcription from one time to another. 3. Musical terms in common use. 4. The compass and registers of the various voices of men, women, and children; general rules relating to voice training.	Students should notice that the larger proportion of marks are given for the practical work, and that the theory paper cannot be taken unless a certificate for practical skill be obtained from some competent person.
			Tonic Sol-fa notation.	
			1. Notes. The major and minor modes. Diatonic and chromatic intervals. Names of chromatic tones. Removes of key; bridge-notes and distinguishing tones. 2. Time. All the measures in common use. Division of pulses into thirds and quarters. Transcription of values by doubling, halving, etc. Accent and syncopation. 3. Musical terms in common use. 4. The compass and registers of the various voices of men, women, and children; general rules relating to voice training.	
Composition - (*f*)	30	—	—	See First Year.
English - - (*f*)	100	Same - - -	(1) (*a*) Grammar. (*b*) Analysis. (2) Language, style, and subject matter of 'Richard II.' and Gray's Poems. (3) Intelligent knowledge of the plot and chief characters in 'The Tempest' and 'Macbeth.	See First Year. The Clarendon Press edition for 'Ric. II.,' 'Tempest,' and 'Macbeth' are advised.
Geography - (*e*)	75	Same - - -	As in First Year.	

Subjects.	Maximum Marks.	Men.	Women.	Notes.
History - - (*a*)	75	Same - - -	As in First Year.	
Arithmetic -	—	—	(1) Arithmetic generally. (2) Alternative Algebra. Four simple rules. Involution. Algebraic Fractions. Simple Equations, one unknown.	A candidate who passed with credit in Arithmetic in the First Year may take :— (*a*) Euclid I. (*b*) Algebra, to Simple Equations, inclusive, instead of Arithmetic.

MEN ONLY.

The subjects are grouped as follows :—

(*a*) English.
(*b*) Geography and History.
(*c*) Algebra, Mensuration, and Geometry.
(*d*) Two subjects of Science.
(*e*) Two Languages.
(*f*) Two of the following :—
  (1) One Language.
  (2) One Science.
  (3) Economy.

All candidates *must* take GROUP (*a*) and TWO other groups, but no more. Group (*f*) may not be taken with (*d*) or (*e*).

A candidate who fails to pass with credit in Mathematics in the First Year papers must take that Group as *one* of the Groups; but he has the option of—

(*a*) Repeating the First Year course, with a maximum 25 per cent. less than for the Second Year course.
(*b*) The Second Year course.

Algebra and Mensuration—
(*a*) First Year's course.
  Permutations and Combinations.
  Binomial (positive integral indices only).
  More difficult equations.
  Logarithms.
  Interest and Annuities.
(*b*) First Year's course.
  Cylinders, spheres, cones.

Geometry—
  Euclid I.–IV., inclusive, and 1–17 in Book VI.
  Simple deductions.

WOMEN ONLY.

Subjects.	Maximum Marks.	Syllabus.	Notes.
Domestic Economy.	75	(1) Choice, preparation, and due economy of articles of food in common use. (2) Preparation of food for the sick. (3) Household Management. (4) Expenses and Investments.	Hughes's 'Domestic Economy,' pages 213–245, 246–279, 413–417.
Needlework - (*f*)	125	Higher branches, including— (1) (*a*) Tucking. (*b*) Whipping. (*c*) Feather-stitching. (*d*) Repairing linen and print. (*e*) Darning in stocking-web stitch. (2) Diagrams— (*a*) Boy's shirt. (*b*) Child's muslin pinafore. (*c*) A woman's nightdress. (3) Cutting out and making one of the above, and cutting out and tacking together of the other two garments.	As in First Year.

GENERAL REMARKS ON ROUTINE.

Each student should make out a Time-table for himself or herself, having regard to—

(*a*) The time that can be spent each day, excluding Sunday and Saturday.
(*b*) The character of the subjects in which the student is strong or weak.

The greater proportion of time should be given to—

(*a*) Weak subjects.
(*b*) Those to which the student has a personal dislike.
(*c*) To the failing subjects.

It should be remembered that the division in which the successful candidate is placed depends on the aggregate marks, and therefore all subjects should be brought up to a good average.

Saturday is a day on which, generally speaking, longer time continuously can be given, and at least *two hours* should be allotted to attempting written answers to questions, and *two* to *revision* of the work of the previous five days.

Revise and write out is the surest road to success.

The syllabus is not yet issued, nor the regulations as to Sciences and Drawings.

So far as is at present known the syllabus will be as given.

The most notable change is the addition to the literature of the second year English.

The distinction between the statements as to what is required in the Gray and 'Richard II.,' and in 'The Tempest' and 'Macbeth,' must be carefully noted. It is clear that it is intended to be the beginning of a course of pure literature.

Next month I shall begin some special notes on this part of the work.

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REVIEWS.

Royal School Series: the 'St. George' History Readers. Book III. London: T. Nelson & Sons.

It is claimed for this book, the first issued of a new series, that it 'exactly suits the requirements of the new Code (1895) for Standard III.' It consists of a number of stories of British history from 55 B.C. to 1485 A.D. These have been specially written for the work, and they are written in a style that cannot fail to prove attractive. The narrative is made the more vivid and picturesque by the frequent introduction of direct quotation of the words of the historical characters concerned in the various incidents related.

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A selection of poems dealing with historical incidents is added, and also a concise chronological summary of the period covered by the lessons.

In typography and all material qualities this book is fully up to the high standard of Messrs. Nelson's school publications, and we believe that if the remaining volumes are produced on the same lines, the series will become a favourite one.

Waddington & Jackman Series. Monthly Progress, Syllabus, Report, and Examination Register. Bolton: R. Waddington. London: Simpkin, Marshall, & Co.

Two active members of the Executive of the National Union of Teachers issue this Register as a help to teachers in gauging the progress of school work. Pages are given for the setting forth of the complete syllabus in ten monthly periods, with columns for reporting the general results of periodical examinations. Other pages afford means of recording the results of individual examinations of 102 scholars on ten different occasions. The list of subjects for which provision is made includes object lessons, varied occupations, and physical exercises, as well as other class and specific subjects. The Register, being covered with red linen, will stand some wear; and it will probably be found a useful aid.

Royal School Series: Girls at Home, a Domestic Economy Reader. London: T. Nelson & Sons.

This special reader for the upper standards in elementary schools consists chiefly of a story of home life, pleasantly written in fifty chapters, each of which is introduced by a suitable motto, selected in most cases from the English poets. The story is one of struggle on the part of a family of girls and boys whose circumstances have unexpectedly become very trying. The struggle is bravely made, and is substantially successful. Its various incidents are made the means of conveying much useful instruction on household management, sanitation, food, cookery, clothing, washing, mending, the sick-room, thrift, marketing, and other allied topics. The more technical explanations are given in footnotes, or arranged in chapters headed 'Jottings from Kate's, or Amy's, Note-book.' A selection of 'Poems of Home' follows the story, and a concise summary of domestic economy is added.

A section is devoted to notes and meanings of words, and another to derivation and word-building.

The paper, print, and general appearance of the book are all admirable.

The School Music Review for May. London: Novello, Ewer, & Co.

The contents of this number are varied and interesting. Mr. Roston Bourke contributes a set of answers to the questions given this year in the music examinations of the Society of Arts. Special attention is called in the editorial notes to the report of a conference in America on 'sight-singing without solfaing.' The music supplied with the number includes a simple unaccompanied glee in three parts composed by J. Stafford Smith, 'The Archer's Glee,' and a part-song, 'The Songs our Fathers Loved,' set to an Irish air harmonised for S.S.A. by Mr. McNaught. Studies in chromatic effects and in the minor mode are also given; and the extra supplement contains an easy two-part song, 'The Skylark.' All the pieces are given in both the staff and tonic sol-fa notations.

Familiar Scenes for Object Lessons: A Post Office. The Seaside. Illustrations of Trees: The Oak, The Ash. London: W. & A. K. Johnston.

Two admirable series of pictorial charts for illustrating lessons are here represented. On one sheet the busy life inside a large post office is depicted in somewhat brilliant colours. The various labels indicating the matters attended to at different parts of the office will afford excellent means of making young children acquainted with an important feature of modern life. The second sheet presents a vivid picture of a seaside resort, with its parade, pier, sands, children, and niggers.

The charts of the trees are divided into two sections. On the right half of the sheet the tree is shown in its summer dress, with a pleasing landscape for background; on the left are diagrams showing the grain of the plain cut wood, and its appearance when varnished, and also drawings of the leaves, flowers, and fruit, and in the case of the oak—the galls or oak-apples. In the diagrams representing varnished sections, the grain is, perhaps, too plain and regular, at least for the oak, and the colour too deep for the wood of the ash.

All the charts are produced in excellent style.

School History of Australia and Tasmania. By G. Thornton. Sydney: Turner & Henderson.

Mr. Thornton has succeeded in producing a most interesting and lucid record of the discovery, growth, and development of the various colonies of the Great Southern Land. We are apt, in England, to dwell only on the wonderful advance and the great natural advantages of the Island Continent, overlooking the difficulties and trials of the pioneers of colonisation. It is most interesting to follow the graphic account here given us of the obstacles presented to the various colonies in their early years, and how they have been fought and eventually overcome. The explorations of Bass and Flinders, Leichardt and Sturt, Burke and Wills, were attended with as much danger as those of Speke, Baker, Livingstone, and Stanley, and were pushed forward with the same indomitable pluck and perseverance.

No student of Australian geography should be without this book.

Poetic Selections for Schools. By J. W. Kevin, Inspector of Schools, New South Wales. Sydney: Turner & Henderson.

In the hurry and rush of development, Australia has not yet had time to produce any great poet. Hence the same poems which we teach are learnt by the children under the Southern Cross. There are some short pieces by Australian writers which would deservedly find a place in any book of poetry. The selections are judiciously made, and calculated to inspire a love for the poetic literature of the mother country.

My Centennial Gift: Australian Stories for Children. By Archer Ferres. Sydney: Turner & Henderson.

This is a collection of stories dealing principally with Australian animal life, and told with great charm of manner. The children of New South Wales, who might not be interested in tales of troll and gnome, fairy and pixie, would be quite at home with the platypus, wombat, pademelon, bandicoot, wallaby, mopoke, and koala. We have little doubt that Mr. Ferres 'gift' will be widely read and much appreciated.

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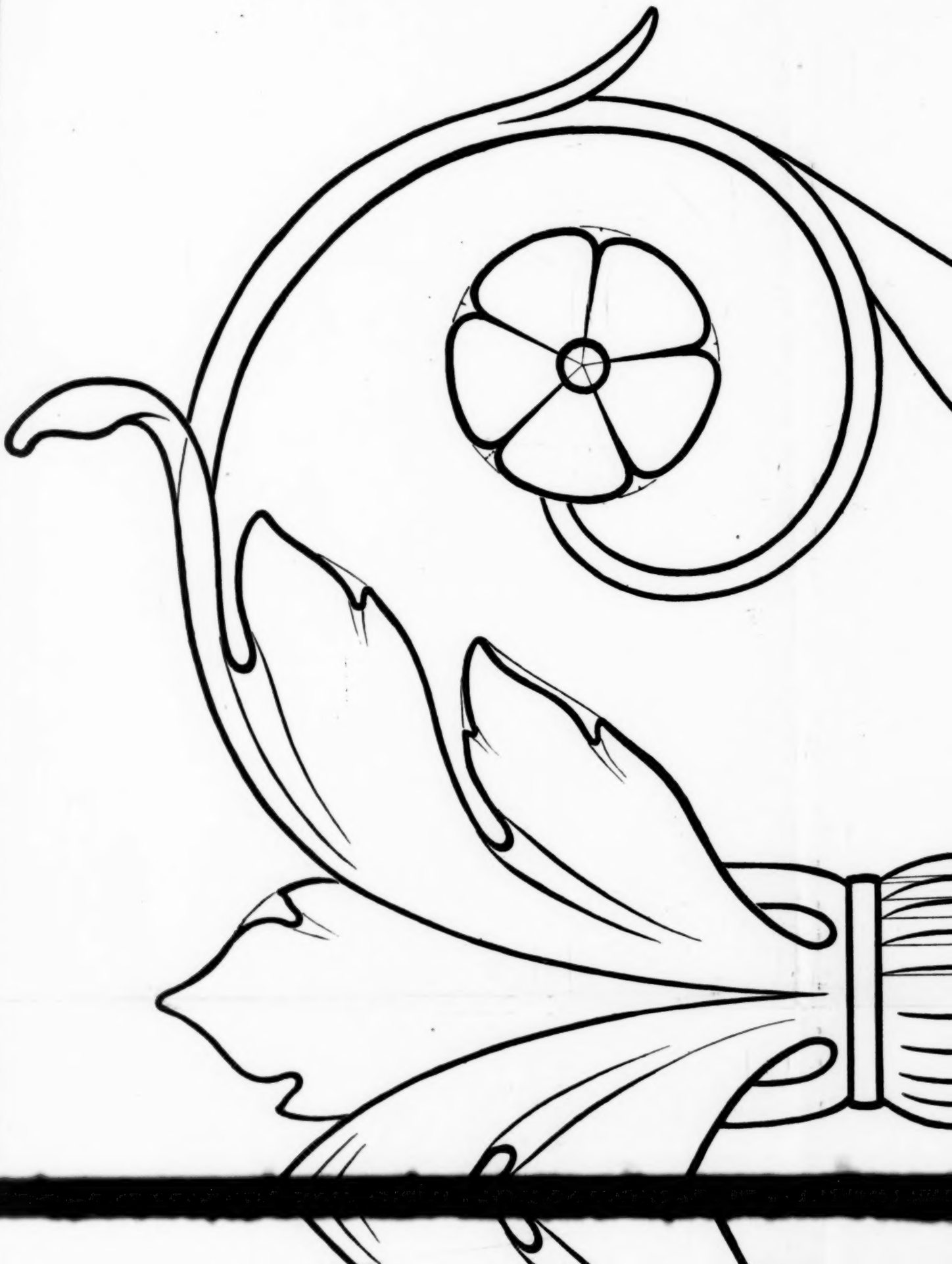

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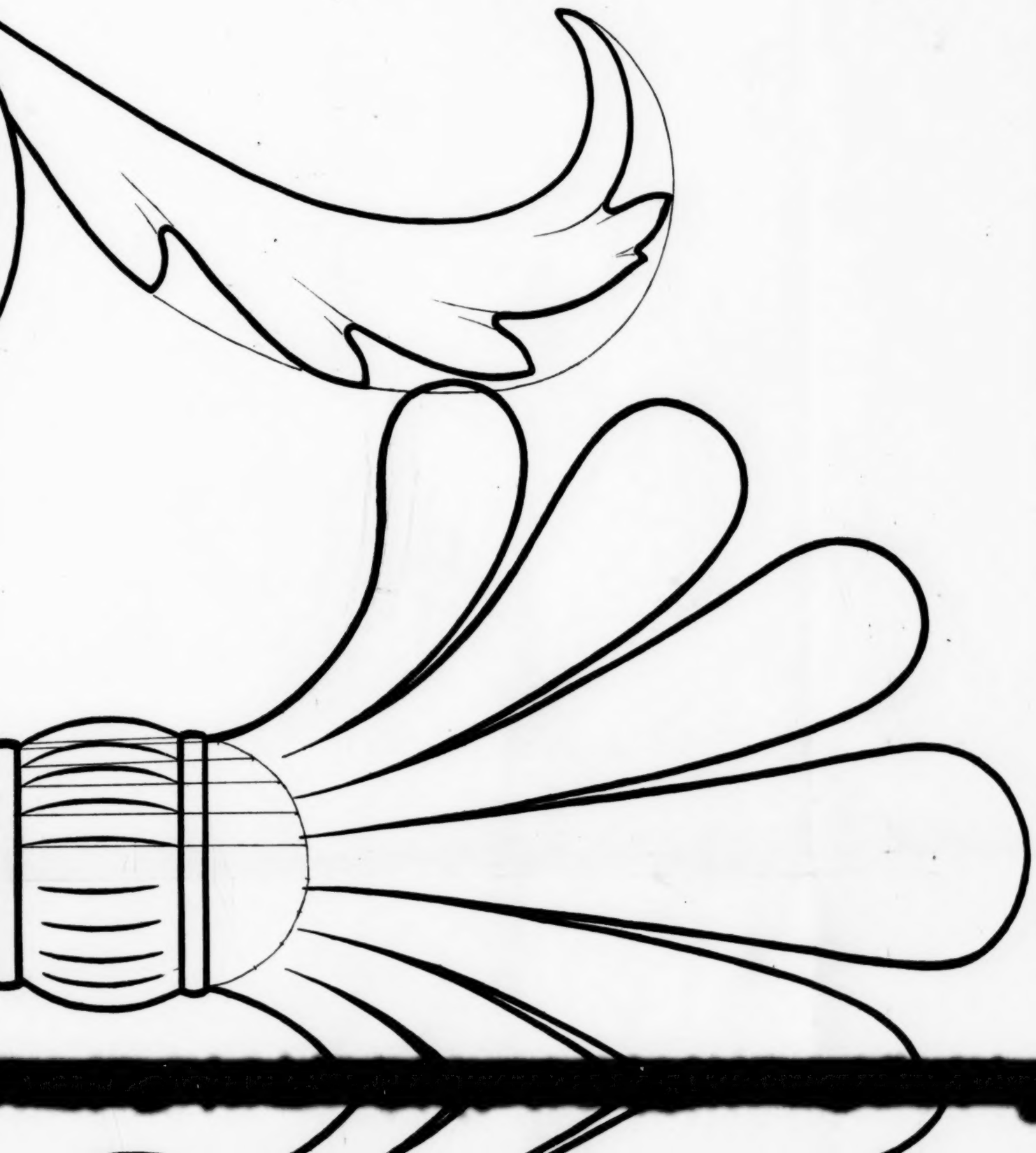

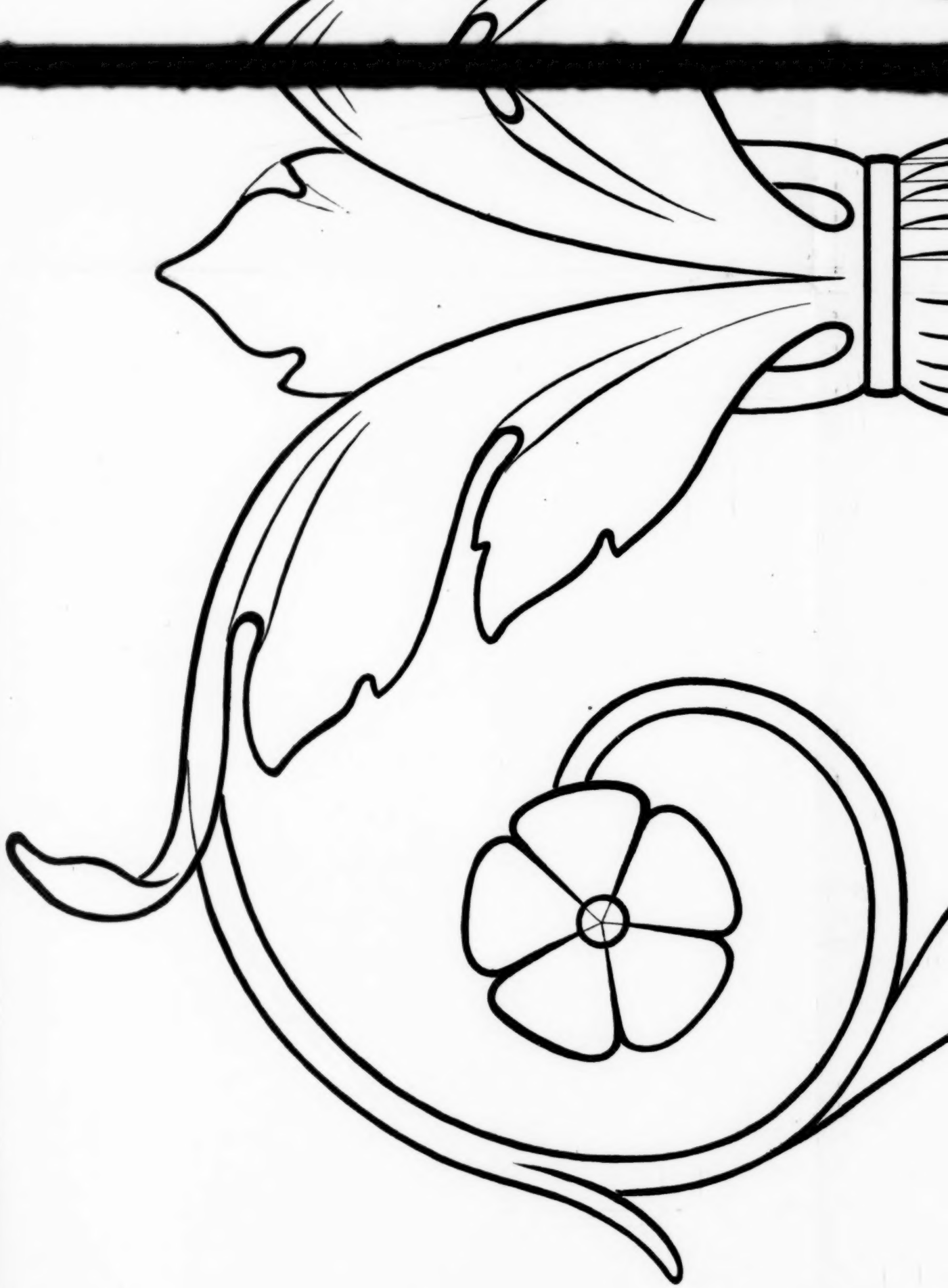

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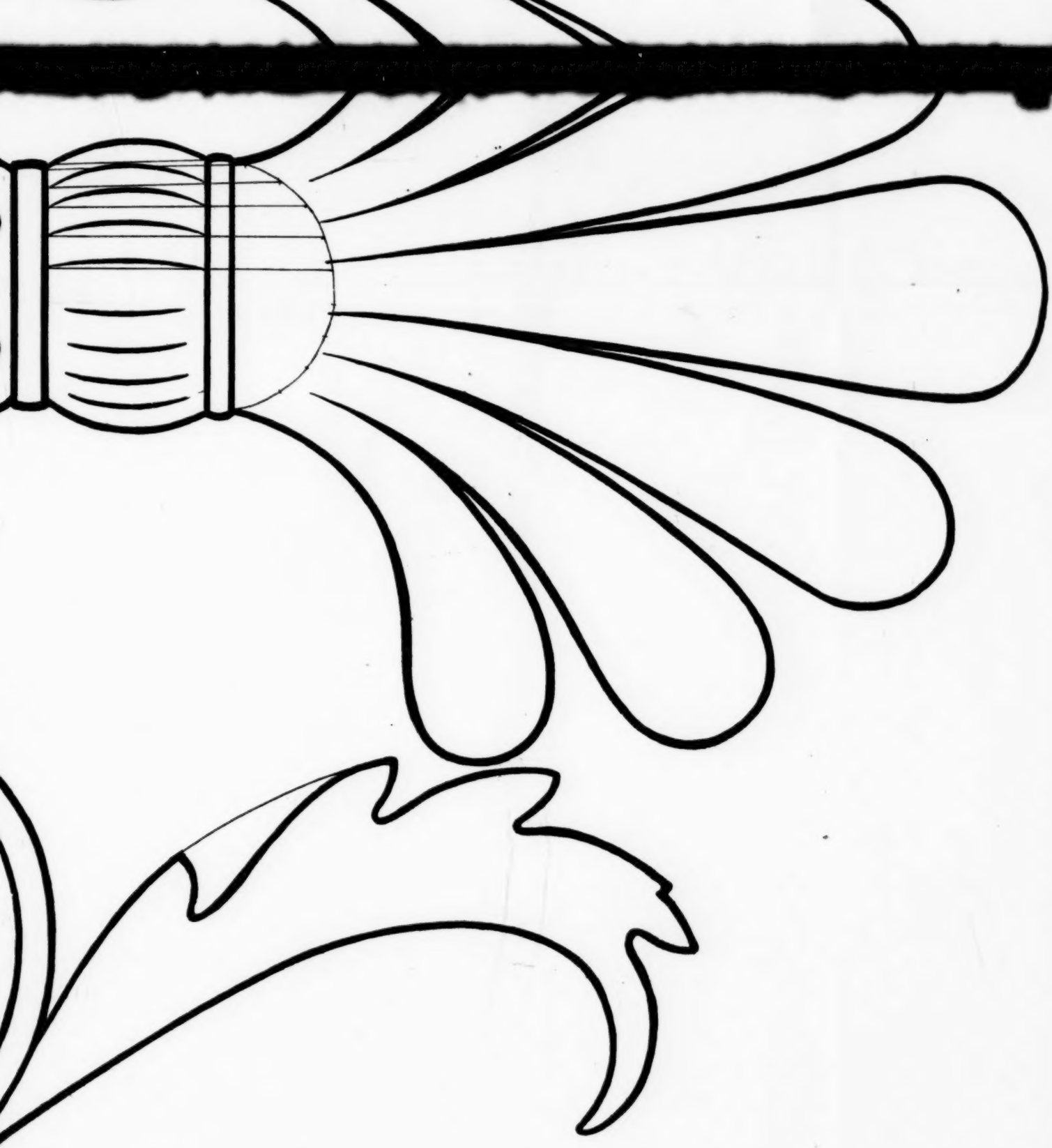

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